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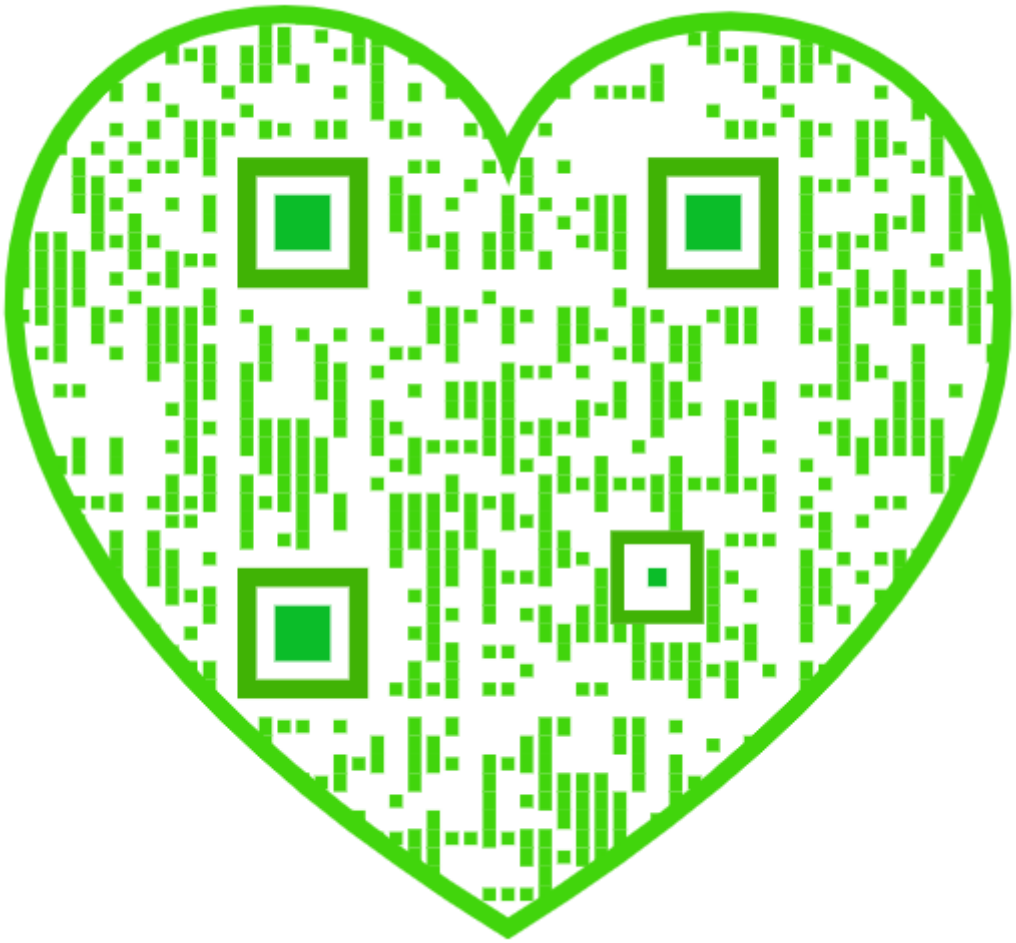

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DEPARTMENT OF AGRICULTURE

VICTORIA, AUSTRALIA

BULLETIN No. 31

(New Series).

BEE-KEEPING IN VICTORIA

By

F. R. BEUHNE,

Government Apiculturist.

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Blossom of Yellow Box Eucalypt.

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PREFACE.

This Bulletin, into which are collected the articles on Bee-Keeping which have appeared in the *Journal of Agriculture* from January, 1912, to April, 1915, is not intended to take the place of a text book of Bee Culture, but as a guide that should enable the reader to employ profitably such of the information as is contained in the standard works of other parts of the world, and has been approved of as suitable by the practical experience of Australian apiarists.

I am afraid that an immense amount of effort and time has been and is still being wasted in attempts to follow the methods and practices of other countries, which however successful where they originated are often quite unsuitable for our Australian seasons and flora.

Bearing this in mind, and aware that the searcher for knowledge is often confused and bewildered by the multiplicity of advice given and choice offered, much of the matter not essential to the successful practice of Bee-Culture usually found in Bee Books has been entirely omitted, and of numerous methods only those best suited to Australian conditions are given.

The illustrations are from original photographs, with the exception of three, reproduced from Root's *A B C of Bee-Culture*.

The honey flora of Victoria is not included in the present publication; it is being dealt with in a series of articles appearing in the *Journal of Agriculture*, and when complete will also be published as a separate Bulletin.

F. R. BEUHNE.

Bee-Keeping in Victoria.

By F. R. Beuhne, Government Apiculturist.

No other rural occupation will give a better return for the capital invested and the labour applied than bee-keeping, if intelligently pursued.

In the State of Victoria, and in Australia generally, bee culture is still in its infancy. Large numbers of colonies are still kept in box-hives, and, therefore, the statistics of production do not convey a correct idea of the possible scope of the industry. There are, however, a limited number of specialist bee-keepers, working with the most modern appliances, and their returns for a number of years indicate the great possibilities of development of the industry.

A Typical Victorian Apiary.

I.—Location.

Bee-keeping in Victoria is carried on under different conditions to those existing in other countries. In the Northern Hemisphere, and also in New Zealand, the principal supply of nectar comes from ground flora on meadows, roadsides, fields and woods. In Victoria, we depend almost exclusively on our eucalypts and a few other native trees and shrubs. Owing to our hot summers, which prevent the secretion of nectar in soft herbaceous plants, except on irrigated land and in exceptionally cool districts, the amount of honey obtained from other than native flora is small in comparison with the quantity harvested from eucalypts.

Even where climatic conditions are favourable to the secretion of nectar, the system of closely feeding down pastures, which is largely

practised in Australia, does not permit of the proper development of the nectar-producing plants and the maximum production of nectar. As probably over 90 per cent. of the honey produced in Victoria is obtained from eucalypts, this fact should be borne in mind when selecting a district in which to commence bee-keeping.

With the opening up of country to settlement, the natural honey resources are to a large extent destroyed. It is a natural and inevitable result and no claim can be made on behalf of bee culture to have the whole of the country kept in its natural state.

Every country, however, must have forests and timber reserves to maintain the supply of timber, to protect the sources of water supply, and to exercise a beneficial influence on the climate. As the forests of Victoria are now permanently reserved and are being improved by thinning, protection against fires, and new plantations, they afford ample scope for apicultural enterprise and a great expansion of the bee-keeping industry. Moreover, the advent of irrigation settlement on a large scale, together with the practice of cutting fodder crops instead of feeding them off, will make bee-keeping profitable in many places where, under the old system of continuous eating off, it could not be engaged in.

Profits of Bee-keeping.

One of the first questions asked by people becoming interested in bee culture is—How much honey will each hive produce in a season? This question is a very difficult one to answer, as the return per hive depends upon three main factors. The first is the flora and climate of the locality where the bees are kept. The second, the ability and experience of the bee-keeper, and, third, the race or strain of bees kept. A return of 20s. per hive per annum for a number of years may be considered a fair general average. For different apiaries, the return may vary all the way from nothing up to 80s. per hive, according to the character of the season, the flora of the locality, and the skill of the bee-keeper. Taking 20s. as a fair general average per hive, it must not be assumed that the annual income can be increased indefinitely by increasing the number of hives. The number of hives kept is limited to what the owner can personally supervise, and what the locality will carry without overstocking it, and thereby reducing the yield. A skilled and experienced apiarist can manage 200 colonies without assistance if located in one or two apiaries not too far apart.

Examples of what has actually been done by apiarists given hereunder will indicate the possibilities of the industry.

Mr. ———, a city dweller, commenced bee-farming in 1906. He had no previous experience. At the end of that year he had 50 hives; at the end of 1911 he had 270, and received £406 13s. 5d. for his products.

Mr. ——— commenced operations in—

	No. of Colonies.	Honey Return.	Wax.	Value.
		lbs.	lbs.	£ s. d.
1905–6	.. 84	.. 3,780	.. 40	.. 49 5 0
1908–9	.. 140	.. 49,200	.. 410	.. 635 0 0
1912–13	.. 150	.. 30,000	.. 280	.. 391 0 0

Mr. ——— commenced in 1900 with two hives; has now 200 hives, obtaining £375 for honey only, and values his apiary at £4,000.

Mr. ——— commenced in 1899; for fourteen years he has averaged £337 per annum.

Bee-keeping, if adopted as a calling by any one having an aptitude and love for it, combined with good business methods, is a profitable and fascinating occupation. If carried on in connexion with some other rural industry, it is a valuable side issue; if pursued as a hobby, it is highly interesting. Bee culture is, above all things, a healthy outdoor occupation of a not too laborious kind, to which many more might turn with whom city life and an indoor occupation do not agree, and who either do not possess the physical strength or the inclination to engage in some other more monotonous and laborious rural occupation.

Selection of Locality.

For the purpose of becoming conversant with the habits of bees, to get some practice in handling them, and to gain the knowledge and experience not obtainable from literature, bee-keeping may be commenced almost

A Bee Farm in East Gippsland—An Ideal Situation for an Apiary.

anywhere. When, however, it is taken up as a business, a suitable district is essential to success. In selecting a site, due consideration should be given to the two main factors; namely, the amount and variety of bee flora within a radius of two or three miles of the site chosen. The permanency of the bee flora is, however, the most important consideration, and the intending bee-keeper should locate on, or close to, some permanent forest or other reserve, so as to avoid the risk of having his honey resources destroyed by the ring-barking of the trees.

In some of the best honey country in Victoria, consisting almost entirely of yellow box and red gum for many miles in extent, there is a deficiency of pollen-producing plants before and after the honey-flow. With a scarcity of pollen, colonies cannot attain their maximum development, and therefore the best results can only be obtained where the bees, prior to the honey-flow, are kept elsewhere. Thus, a practice has sprung up amongst

bee-keepers of having two sites for an apiary—one for breeding up in spring and wintering; the other for securing the honey crop. The moving of the bees from the winter site to the honey country, and back again when the honey-flow is over, entails a considerable amount of work, which can be avoided if a site is secured on the border line of the two classes of country.

Licences.

When locating on forest or other Crown lands, it is necessary to obtain two licences—a bee-farm licence for one acre upon which to place the apiary, and a bee-range licence which secures to the holder the exclusive use of the bee flora for a radius of one mile. No other bee-farm licence is allowed at a lesser distance than two miles. The payments to be made are 10s. a year for a bee-farm site, and ½d. per acre for the radius of the bee range, or about £4 4s. a year.

Site of Apiary.

Having decided upon the locality, the spot upon which the hives are to be set out should be selected, with due regard to its suitability for the bees and convenience of working the apiary.

An even, gently sloping surface, of gravelly or sandy soil, will be found most suitable. It should, if possible, be sheltered by a natural or artificial breakwind on the south and west. A slope to the north or east is preferable to one to the south or west.

The honey-house should be placed at the lower end, and the hives arranged in such a way that a good general view can be obtained from the door and windows of the building, so that during the swarming season the apiary may be under observation while necessary indoor work is being done. Having the building at the lower end of the ground has the double advantage of getting a better view of the whole apiary and of moving the supers of heavy honeycombs down hill at extracting time

It is not advisable to stand hives under evergreen trees, such as pines or eucalypts. Colonies in permanently shaded positions never thrive so well as others out in the open. If placed under deciduous trees, as for instance in an orchard, the hives will have shade during the hottest part of the day in summer, and sunshine during the cold months of the year when the trees are not in leaf.

Arrangement of Hives.

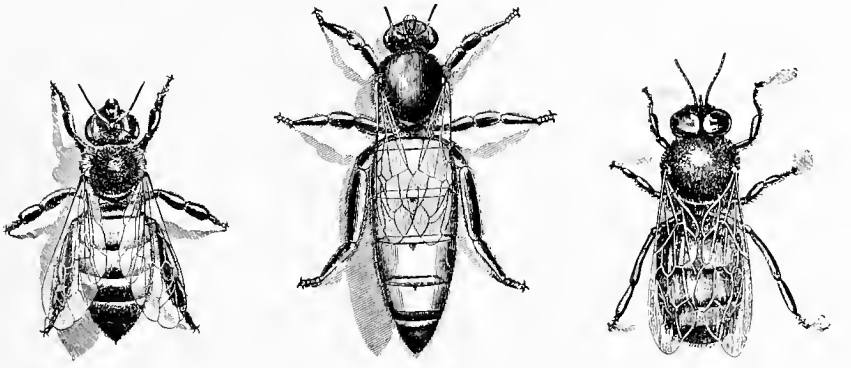
In laying out the apiary, it is better to place the hives in groups of twos, threes, or fours, with a longer distance between the groups, than to stand the hives singly in rows. The group system lends itself better to the various necessary operations of uniting or dividing colonies and in moving about amongst the hives; it gives more space between the groups than would be the case between the same number of hives placed singly.

When grouping hives, the entrances should point in different directions. None, however, should face the south, as the strongest and coldest winds come from that quarter. It is also advisable to vary the grouping so that no two adjoining groups will be exactly alike. This will to a great extent prevent the straying of returning field bees and the loss of virgin queens returning from their mating flight. The latter frequently occurs when hives stand in symmetrical rows and without any variation in the arrangement and without distinguishing landmarks.

II.—The Bees.

There are many terms used in connexion with bees which are liable to cause misunderstanding when wrongly applied by the uninitiated. Some of these words have a general as well as a specific meaning. Any community of bees may be called a colony, but in practice the term is only applied to bees established in a dwelling provided by man. Colonies in trees, rocks, or other natural abodes are known as bees' nests. While a hive of bees denotes a colony in an artificial dwelling the dwelling itself without bees or combs is known as a bee hive. Communities of bees on the wing, clustered outside away from the hive, or inside the hive without combs, are called swarms.

Every normal colony of bees in the active season consists of three classes of individuals, viz., the queen, a large number of workers, and a variable number of drones. The queen is the mother of all the other bees and the only fully-developed female. The workers are sexually undeveloped females, and constitute the largest part of the colony, numbering from 40,000 to 70,000 in a strong colony in the height of the season.



Worker Bee, Queen, and Drone of the Italian Bee.
(Reproduced from A. I. Root's *A B C of Bee Culture.*)

On the average, it takes 4,500 worker bees to equal one pound in weight. The drones, which are of larger size than the workers, are the males, and their only use in the economy of the hive is to mate with the virgin queen. Towards autumn, when they are no longer required, or at any time during a scarcity of nectar, they are driven out of the hive by the workers and left to die of starvation, except in the case of a colony with an old or failing queen, or a queenless stock. Both of these will retain their drones and also admit those expelled from other hives—a provision of Nature to enable the mating of the future young queen to take place.

Life History.

A knowledge of the life history of bees will assist any one to better understand what conditions are necessary to the highest welfare of the colony and the maximum profit to the bee-keeper. While such knowledge will not take the place of practical experience in the management of bees, it will form a good basis for an understanding of the various manipulations.

The bee, like other insects, goes through four stages of development, viz., (1) egg, (2) larva, (3) chrysalis, and (4) imago or perfect insect.

The ovaries of the queen contain up to 500,000 eggs, which she deposits in the cells of the comb during the breeding season—after the cells have been prepared for her by the worker bees. The life of a queen bee is about three years. Under the most favorable conditions, she will deposit up to 3,000 eggs in twenty-four hours. The eggs in the ovaries of the queen are all alike as to sex. The act of fertilization takes place in the oviduct when the egg is on its way out, *i.e.*, it is to produce a female—a queen or a worker bee; the egg producing a drone is not fertilized. Thus, even a queen which has never met a drone will, after a delay of two or three weeks, deposit eggs. None of these, however, can produce anything but drones. This reproduction without fertilization was first discovered by Dr. Dzierszon in 1853. It is known as parthenogenesis or virgin-development, and has a very important bearing on practical bee culture.

The drones of a pure bred queen of any race are always pure of the same race, even though the queen herself was mated to a drone of a different variety. Thus, by having one single pure bred and purely mated queen, and raising from her eggs a new queen for each colony, the race or strain of bees of an entire apiary of hundreds of colonies may be changed in one season. As each young queen is pure bred, her drone progeny are also pure, irrespective of how she mated. The following season there will therefore be none but pure drones in the apiary. All young queens will then be mated to pure drones; and, if from a pure bred mother, will produce queens, workers, and drones of pure race. The mating takes place in the air, often a considerable distance away from the apiary, and some of the queens will most likely be mis-mated when other bees exist within two miles of the place.

Fertilized eggs are deposited by the queen in the smaller or worker cells of the comb; the cells are 1-5 in. in diameter—twenty-five to a square inch of comb surface. Unfertile eggs are laid into drone cells, which are $\frac{1}{4}$ in. wide—sixteen to the square inch. By the use of full sheets of comb foundation in the frames of the modern hive, the raising of drones is reduced to a minimum, because the wax sheets are embossed with the pattern of worker comb only. Any egg which is fertilized, and would in the ordinary course produce a worker bee, can at the will of the nurse bees be made to produce a queen, when necessary. This fact is made use of in what is known as artificial queen-rearing, by depriving a suitable colony of its queen and brood and substituting a comb containing eggs or young larvæ from a queen of the race or strain desired.

After the egg which produces a worker is laid, it remains unaltered for three days. It is then supplied with a minute quantity of larval food by the nurse bees, and a scarcely visible grub or larvæ, which lies coiled at the bottom of the cell in the shape of the small c of ordinary type emerges. It grows rapidly; and, on the sixth day after emerging from the egg, it assumes an upright position in the cell. The worker bees cap the cell with a paper-like substance, the grub meanwhile spinning a cocoon round itself in the cell. The young bee has now entered the third or chrysalis stage, from which it emerges as the perfect insect, eighteen days from the time the larva first appeared, or twenty-one days since the egg was laid. In the case of the queen, the time of development is five days less, *i.e.*, three days in the egg stage, six days in the larval state, and

seven days as chrysalis, or sixteen days in all from the time the egg was laid to the young queen emerging from the sealed cell.

The drone is in the egg for three days, larva seven days, and chrysalis fourteen days, or a total of twenty-four to twenty-five days from the egg to the perfect insect. The following table may be useful in showing the variations in the time of development:—

NUMBER OF DAYS OF DEVELOPMENT.

—	In the Egg.	Larva.	Sealed Cell.	Total.
Worker Bee	3 days	6 days	12 days	21 days
Queen	3 "	6 "	7 "	16 "
Drone	3 "	7 "	14 "	24 "

III.—Races of Bees.

Of some twenty known varieties of the honey bee (Apis mellifica) four only have been introduced and established in Australia, viz., the Black Bee; the Italian; the Cyprian; and the Carniolan.

The Black Bee, it has been stated, was first brought to Tasmania from Great Britain in 1824. From Tasmania some hives were taken to Sydney and from thence the variety has spread pretty well over the whole of Australia. It is hardy and will fly on cold and wet days when some of the other races will not leave the hive, and it commences brood rearing very early in spring—almost in midwinter. As in the raising of brood, pollen, the fertilising dust of flowers, is required, the black bee is a most important factor in the fertilisation of the blossoms of the earliest flowering kinds of fruit trees. In cool districts, or when the pollination of fruit blossom is of greater importance than the yield of honey, the black bee or one of its crosses with Italian or Cyprian is probably the best kind of bee to keep. On the other hand, Blacks, although commencing to breed early, do not maintain a high rate of reproduction for long and, where the main honey flow occurs in summer, do not give as good a yield of honey per hive as Italians. They are excessive swarmers, more excitable when handled than the other races, offer less resistance to foulbrood, and often allow wax moth grubs to infest their combs.

The Italian Bee was introduced in the seventies. It is of somewhat lighter build than the Black and has three yellow or light orange coloured bands across the abdomen. It is gentle and little inclined to sting when properly handled. Italian queens, even those imported direct from Italy, vary greatly in colour, some are quite yellow, and some almost as dark as black queens; whilst others have dark and yellow bands. The colour of the queen is therefore no indication of purity of race, the best proof of which is the uniform markings of all her worker progeny. Italian bees cling tightly to the combs when the frames of combs are handled, while black bees or hybrids often drop off without shaking. Pure bred Italians, and, to a lesser degree their crosses with others, are more immune from foulbrood, and rarely allow wax moth grubs to get into their combs. They begin breeding later in spring than Blacks, but at the approach of warm weather soon overtake the latter and maintain a greater worker force throughout the season. A variation of the

Italian is the Golden Italian which was secured by select breeding for colour, or by crossing with Cyprians. It has five yellow bands instead of three—practically the whole of the abdomen is yellow. Bees of this variety are more susceptible to cold and wet than the three banded Italians and rather predisposed to Bee-Paralysis. Italians, when pure, do not cap their combs so white as black bees do, and are therefore less suitable for the production of comb honey.

The Cyprian in appearance, and many other respects, resembles the Italian. It is somewhat slimmer, the yellow rings are of a deeper shade, and the fuzz rings of the segments whiter. Cyprians are good breeders, sometimes continuing brood rearing when a honey-flow has stopped till all stores are consumed. They raise a large number of fine queen cells at swarming time or when made queenless. Their undesirable characteristic is viciousness during a dearth of nectar, when even the use of smoke, so effective with other races, will not subdue them. As they are not superior to Italians in honey gathering they are not desirable, and not many are now kept in Victoria.

The Carniolan is one of the more recent introductions, in appearance and habits resembles the black bee, from which it is distinguished by the greyish colour of the segment rings. Carniolans are excessive swarmers, as gentle as Italians when pure, but owing to their close resemblance to blacks it is difficult to maintain purity of race. Taking the experience of the largest honey producers of this State for guidance the three banded Italians can be recommended as the best bees to keep for honey production.

Handling of Bees.

The sting of the bee is an important factor in preventing over production of honey. There are many persons who have an almost unreasonable fear of bees, or, rather of getting stung, and yet there are very few people to whom a sting causes more than a sharp pain for a short time and some discomfort through swelling of the affected part. Both pain and swelling become less and less after a number of stings have been received and the seasoned bee-keeper, while reducing the number of stings he receives to a minimum by observing certain rules, takes little notice of the stings he does receive beyond removing them promptly. There are, however, some individuals to whom a sting causes serious pain and protracted discomfort, and to whom bees have a lasting dislike—attacking them whenever they come near hives. Such people should have nothing to do with bees. Most, however, after being stung a number of times

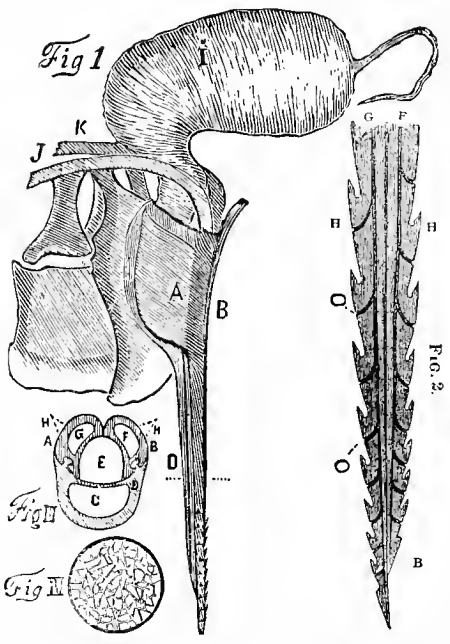


Fig. 2.

(Reproduced from A. I. Root's *A B C of Bee Culture*.)

become more or less immune, even though the first few stings caused considerable pain and swelling. With the right strain of bees; an understanding of their habits; correct methods of handling; and a knowledge of irritating causes the largest apiary can be run without more than an occassional sting being received.

Of late years bee stings have been used by medical men for the cure of certain forms of rheumatism. That the poison of the sting has no lasting injurious effect upon the human system seems evident from the fact that many prominent men who have lived amongst bees all their lives have attained to extreme age, *e.g.*, Dr, Dzierszon, Rev. Langstroth, Dr. C. C. Miller, A. I. Root, and others.

To avoid stings as much as possible one should dress in light coloured clothes, bees have a rooted objection to anything black, and more so when it is rough or fuzzy The odours of such things as camphor, kerosene, turpentine, eucalyptus oil, carbolic acid, lysol, dogs, horses, ants, or meat, on the hands or clothes of the operator, or anywhere near the hive, will cause bees to sting. In their attacks on trespassers (as in their search of nectar) bees are largely guided by the sense of smell. The odour of flowers attracts them to the spot where the flowers grow, while the sense of sight locates the blossom.

When approaching a hive one should walk lightly and avoid standing in the line of flight of the bees leaving the hive or returning to it. Before opening the hive blow a whiff of smoke from the smoker in at the entrance, and another one or two over the top of the frames as soon as the hive cover is raised sufficiently. When these precautions are taken there need be little fear of stinging unless the bees are of a vicious strain, in which case the queen should be removed and one from a gentler stock introduced. There are, however, occasions when even the best tempered bees will sting more or less viciously For instance, when a honey flow has suddenly ceased and bees have had access to honey other than the nectar in flowers; or when a colony has become hopelessly queenless, which means that they have no queen and no brood to raise one from. The remedy in the first case is never to allow bees access to honey outside the hive, and not to open hives when robber bees are seen hovering round. In the second, give the queenless colony a comb of brood from another hive, or introduce a queen.

To reduce the effect of a sting to a minimum it should be quickly removed, when very little of the poison will have entered the puncture. The sting itself is a sharp-pointed and barbed hollow shaft connected with the poison sac in the body of the bee. When the sting has entered the rubberlike human skin it cannot be withrawn on account of the barbs, and in the effort of the bee to free itself the sting with the poison bag, and the actuating muscles attached, is torn from the abdomen. The muscles may be seen to continue working sometimes for many seconds after the sting has become detached from the bee and it is therefor advisable to immediately remove it from the skin. This is best done by scraping it away with the fingernail or if both hands are engaged rubbing it off on your clothes. On no account should a sting be picked off with the finger tips because that cannot be done without pressing the poison bag and injecting the whole of its contents into the skin.

To neutralise the effects of a sting a number of remedies are recommended. The blue bag is the most commonly advocated cure—I am not at all sure whether green or yellow would not do as well.

Ammonia is certainly more effective, but it has the disadvantage of irritating the bees, and more stings are likely to be the result. Washing the part stung with soap and water allays irritation, whilst if many stings have been received bathing with hot water will diffuse the poison, lessen the pain, and reduce the swelling. For the average individual the best thing to do is to quickly remove the sting and think no more about it.

IV.—Hives.

The hive most generally in use in Victoria is the "Langstroth" either eight or ten frame. There are however a number of beekeepers who use a modified form of the Heddon hive. Whatever hive is adopted the walls should not be less than $\frac{7}{8}$ inch in thickness, otherwise extremes of temperature will affect the bees, and during very hot weather combs may melt down. All hives sold by manufacturers are made of $\frac{7}{8}$-inch wood, and I strongly advise beginners who intend to make their own hives not to use thinner boards.

The eight-frame Langstroth hive, as shown in Fig. 5, is made of $\frac{7}{8}$-inch shelving, pine, or Californian redwood. It measures 20 in. by $13\frac{7}{8}$ in. outside, and is $9\frac{1}{2}$ inches deep, giving an inside measurement of $18\frac{1}{4}$ x $12\frac{1}{8}$ x $9\frac{1}{2}$. The ten-frame Langstroth is of the same length and depth, but of 16 inches outer and $14\frac{1}{4}$ inches inner width, thus giving room for two more frames. The end boards of the hive are rebated inside to a distance of $\frac{7}{8}$ inch down and $\frac{1}{2}$ inch into the thickness of the board. On to the shoulder of this rebate is nailed a runner of folded tin so as to project $\frac{1}{4}$ inch upwards. On this metal runner rest the top bars of the frames, and its purpose is to prevent the crushing of bees when handling frames and to avoid the gluing down of the latter by the bees.

Two kinds of frames are sold by dealers, the Simplicity and the Hoffmann. The outer dimensions of both are the same, viz., $17\frac{5}{8}$ in. x $9\frac{1}{8}$ in., with the top bar 19 inch long, but while in the Simplicity, or loose hanging frame, top, side and bottom bar are all of the same width, viz., $\frac{7}{8}$ inch, in the Hoffmann, or self-spacing frame, the upper part of the side bars is $1\frac{3}{8}$ inch wide. When pushed close together in the hive, they give the correct spacing of the combs, viz., $1\frac{3}{8}$ inch, which is the average distance at which bees build combs when in a state of nature. Eight or ten frames in the respective hives leave a small space, this is occupied by a thin board of the dimensions of the frames and called the follower and its object is to more easily remove or handle the frames after it is withdrawn. The thickness of the bars of the Simplicity frame is top bar $\frac{1}{2}$ inch or $\frac{5}{8}$ inch, reduced to $\frac{3}{8}$ inch at the projecting ends; side bars $\frac{3}{8}$ to 7-16 inch; bottom bar $\frac{1}{4}$ to $\frac{3}{8}$ inch. In the Hoffmann frame the thickness and width of the top bar varies with different manufacturers, American frames having a top bar 1 inch wide and $\frac{7}{8}$ inch thick, while some frames of local make have a top bar $\frac{7}{8}$ inch wide, and $\frac{1}{2}$ inch or $\frac{5}{8}$ inch thick. The bottom bar is $\frac{3}{4}$ inch x $\frac{1}{4}$ inch in all the different makes. Whatever the thickness of the bars the outside measurement of the frame is always the same.

The Simplicity frame is the cheapest and easiest to uncap for the extraction of honey, but, being a loose hanging frame, it has some serious disadvantages. Each frame has to be spaced separately every time bees are handled, and as there is a $\frac{1}{2}$-inch space between the frames

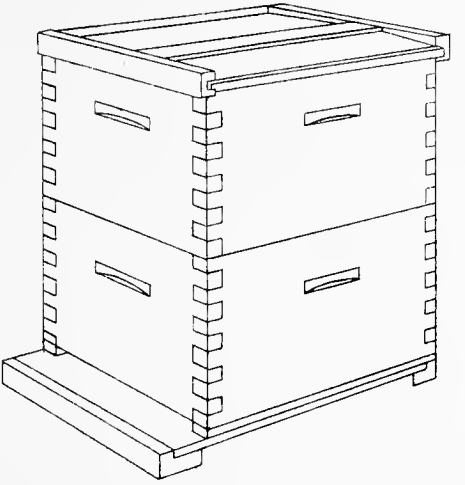


Fig. 5.—Eight-frame Langstroth Hive, Two Storey.

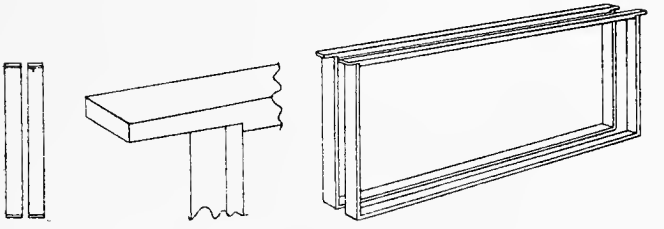


Fig. 6.—End and General View of Simplicity Frame.

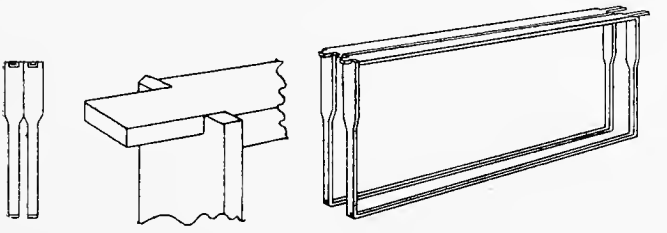


Fig. 7.—End and General View of Hoffmann Frame.

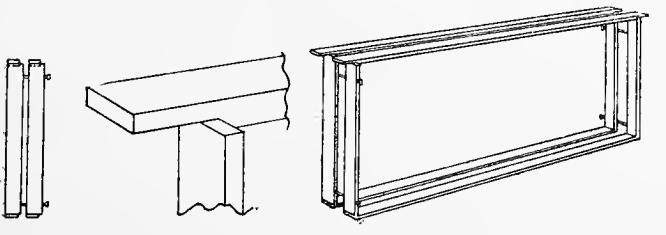


Fig. 8.—End and General View of New Frame.

when correctly spaced the bees will often build comb into these spaces and on to the end wall of the hive. Further, every time a hive is moved the frames have to be secured in some way to prevent them knocking against one another and crushing bees, and for these reasons self-spacing frames are more advantageous. The difference in the first cost between Simplicity and self-spacing frames is only 2s. to 2s. 6d. per hundred frames. Wide top bar Hoffmann frames as used in America are somewhat difficult to uncap when extracting; as the comb of honey when sealed does not project beyond the wide top bar, it cannot be used as a guide for the uncapping knife, as can be done with the Simplicity or the Hoffmann, with a $\frac{7}{8}$ inch x $\frac{5}{8}$ inch top bar as shown in Figure 7.

One drawback of Hoffmann frames is that the bees often fasten the side bars of the frames together with wax or propolis. The latter is a substance gathered by the bees for the purpose of filling up any interstices or crevices in the hive. It consists of resin, wattle-gum, tar, paint, cart-grease, and similar substances. In some districts, propolis is a great nuisance to the beekeeper. Some strains of bees will daub it everywhere inside the hive. To overcome this difficulty, and also that of uncapping Hoffmann wide top bar frames, and yet have a self-spacing frame, a number of apiarists, including the writer, has adopted the frame shown in Figure 8. It has a top bar $\frac{7}{8}$ inch wide, $\frac{1}{2}$ inch thick, bottom bar $\frac{7}{8}$ inch x $\frac{3}{8}$ inch, and side bars $1\frac{1}{8}$ in. x $\frac{1}{2}$ in. The top and bottom bars are nailed on so that the side bar projects on the reverse side at the opposite end. The spacing is obtained by four stout flat-headed nails driven into the side bars and projecting $\frac{1}{4}$ inch, as shown in the illustration (Fig. 8). These frames are not stocked by manufacturers, but will be made to order if ordered in sufficient quantities. They can however easily be made by any one at all handy with tools, the only difference between them and the Simplicity frames being that the side bars are $1\frac{1}{8}$ inch instead of $\frac{7}{8}$ inch, and that the frames are nail spaced instead of loose hanging.

The Heddon hanging frame hive, also known as the Bolton hive, is what is called a sectional hive. The hive consists of shallow bodies $5\frac{3}{4}$ inches deep, with self-spacing frames $5\frac{3}{8}$ inches deep. The advantages claimed for it are that it can be readily expanded or reduced in size according to conditions and season by adding or removing stories; that swarming can be prevented or controlled by means of inverting the sets of frames at intervals, thus causing the destruction of queen cells, and that shallow supers are easier to lift and handle when full of honey, and the shallow combs easier to uncap than deep ones.

As an offset against these advantages, it must be mentioned that the Heddon hive costs more, that double the number of combs have to be handled when extracting, and that the splitting up of the hive into so many sets of frames by the intervening bee spaces has a tendency to retard breeding up in spring.

In connexion with this, I should like to say that the correct bee space between set of frames in the stories of a hive is $\frac{1}{4}$ inch. In the hives purchased from manufacturers too much allowance is made (generally) for shrinkage of timber, leaving up to $\frac{5}{8}$ inch between the stories. This excessive space first acts as a great check on the bees entering the super in spring, while later on it is filled with comb and honey, and is a hindrance and nuisance every time a hive is opened, also causing the death of many bees when frames are replaced in supers without first removing the pieces of

comb which connected the upper and lower frames. With a ¼ inch bee space between the stories there will be little or no bur comb.

Floors.

The hive stand generally sold by manufacturers and dealers consists of a single board 22 inches long, 13⅞ inches wide, and ⅞-inch thick, nailed on to a piece of 3in x 2in. at each end, as shown in Fig. 5. On the top of this board, along two sides are nailed strips of wood 19 inches long, ⅞-inch wide, and 5-16-inch in thickness. A piece of like dimensions, but only 13⅞ inches long, is nailed across one end. These three cleats raise the hive body 5-16-inch, and form a bee-space between the bottom bars of the frames and the hive-stand, and, at the same time, constitute the entrance to the hive. This entrance is 12⅛in. x 5-16-in., and may be contracted in winter by blocking it for one-half or two-thirds with pieces of ⅞in. x 5-16in. wood. It is not advisable to have entrances larger than 5-16-inch., as mice may enter and destroy any combs not occupied by bees. This hive stand is fairly satisfactory, but rather expensive. The projection, which serves as an alighting board at the entrance, is also a somewhat objectionable feature, as it prevents close packing of hives in shifting colonies by road or rail.

A hive stand can be made of half the weight, and at only two-thirds the cost, by substituting ½-in. x 6-in. white Baltic lining boards for the ⅞-in. shelving, and a frame of ⅞-in. x 6-in. white Baltic flooring for the pieces of 3in. x 2in. This frame should be made the length and width of the hive, and 2 inches high, the lining boards being nailed on top, and the three cleats on top again. A detachable alighting board, sloping down to the level of the ground, takes the place of the projection. This stand rests on the ground all round, and the exclusion of draught underneath compensates for less thickness of the floor. If pressed down tight on to levelled ground, it affords no harbor for spiders and other vermin, nor a hiding place for queens (where queens are clipped) at swarming time.

In some districts, particularly in forest country, trouble occurs with hive stands, and even hives, through white ants entering the wood of the stand where it touches the ground, and destroying it, and unless checked, eventually the hive. At a trifling expense in the first instance, this risk may be entirely avoided, by saturating those pieces of the stands which come into contact with the ground with a solution of sulphate of copper, generally known as Bluestone. In a box ½-inch longer, inside, than the longest pieces to be treated, and made water-tight by running boiling wax over all the joints, dissolve sufficient Bluestone in water to make a saturated solution, so that in about a day, with occasional stirring, some of the crystals remain undissolved. The wood to be saturated should be thoroughly dry, and be packed into the box of solution, with bits of stick between the pieces to keep them apart, and a weight on the top to keep them under. Immersion for 24 hours will be sufficient, when the wood may be exposed to air and sun to dry. After the stands are made up the pieces impregnated should be painted or tarred to prevent the bluestone being soaked out by rain water.

Covers.

In the matter of hive covers there is perhaps more neglect on the part of beekeepers than in anything else; and yet upon the cover depends in

a great measure, not only the prosperity and health of the colony, but the durability of the hive itself. When hives, however well made, are covered with bags, palings, bark, or pieces of tin and iron, which materials either absorb the rain or conduct it into the hive by soakage around the edges, one need not wonder to find hives gaping open at the joints with boards warped or cracked, and mouldy combs inside. A hive cover should be watertight above all things, but it should also be constructed so that it will throw the water clear of the hive walls, and prevent the fierce heat of summer and the frost of the winter penetrating from the top. A flat, single board cover cannot fulfil these requirements. Even when kept well painted on the outside and strongly cleated at the ends it will warp, twist, or crack in the heat of summer, and will then not fit down close on to the hive all round. This will give rain water entrance to the interior of the hive and robber bees an opening to hover round during a dearth of nectar.

A gable cover with base board resting flat on the hive surmounted by a pitched roof with eaves projecting down a little below the top of the hive, is most effective, and keeps the hive dry and cool in summer, and warm in winter. This cover, is however, somewhat troublesome to construct, and not suitable for migratory beekeeping, being bulky and of an awkward shape for transporting. After using extensively for a number of years about six different patterns of hive covers, I find that a flat one covered with plain galvanized iron is the best all round. This is made of two layers of boards such as may be got from kerosene and jam cases. The boards of one layer run crosswise to the other, and are nailed together to form an oblong of 20½in. x 14⅜in., that is ½ inch longer and wider than the hive. Strips of board wide enough to project ½ inch all round on the lower side of the cover are nailed to the edge of it. The whole is then covered with a piece of galvanized (plain) iron, No. 26 gauge, measuring 28in. x 18in., and cut in at the corners to allow of it being turned down at right angles and secured at the eaves. A sheet of 26-gauge plain galvanized iron 72in. x 36in., which is a trade size, will thus cover six hive roofs. A hive cover of this description will outlast any other kind. It requires no paint, as the wood is not exposed. There is no warping, as one layer of boards checks the other; it is water and fire-proof; and if layers of non-conducting material, such as paper, are inserted between iron and wood, it is also heat and frost-proof.

V.—How to Make a Start.

How to make a start in bee-keeping will depend upon whether the beginner is taking up bee-culture as a business, or as a side issue of some other occupation. If it is intended to adopt it as the only calling, then the best way is to go as a working pupil with an up-to-date apiarist for a season or two. Even if a premium has to be paid for the first year, it will be less costly than the experience gained by failure. After the first season, a pupil will have learned enough to entitle him to some pay for the second year, or he may be competent enough to run a small apiary on shares with the owner. By the end of the second year, sufficient confidence and experience will have been acquired to make an independent start.

When means or circumstances do not permit of taking a position as pupil in an established apiary, or when bee-keeping is to be only a side issue, then it is best to start in quite a small way. Begin with two or

three hives, and as experience is gained by practice, and knowledge by reading, gradually increase the number of colonies. A book of reference, such as A. I. Root's *A. B. C. of Bee-culture*, will greatly assist in mastering the principles of bee-keeping, and will supply solutions to nearly all the problems which usually present themselves to the novice. Any opportunity to visit an apiary, or to personally consult an apiarist of some standing, should be made good use of whenever it occurs.

Everybody handling bees requires two things to start with, namely, a bee-veil, and a smoker. A veil will cost about 1s. 6d., a smoker 4s. to 7s., according to size, and whether tin or brass. There are two kinds—one straight, the other with a bent nozzle. I strongly recommend the latter (Fig. 1), because any kind of fuel may be used in it without risk of glowing embers dropping from it when directing smoke downwards. Dry decayed wood or bark is better smoker fuel than bagging, rags, or fresh wood, the former giving a cooler smoke and less tar in the smoker.

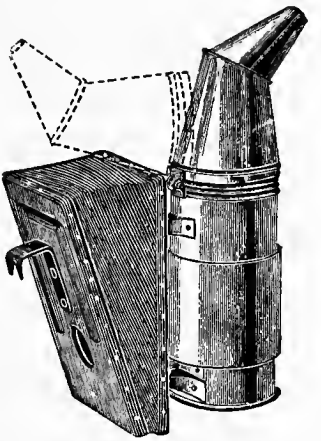


Fig. 1.

There are several ways of making a start in a small way:—(1) Full colonies; (2) Swarms; (3) Box-hives; (4) Nuclei. With which of these to start will depend upon the amount of money it is proposed to expend at once, and whether bees are obtainable in one form or another.

1.—*Full Colonies of Bees.*

Hives with finished combs and brood, and sufficient bees to cover all the combs, may be obtained from supply dealers advertising in the Melbourne weekly papers, at prices ranging from 30s. per stock for Black or Hybrid bees, to 45s. for Italians, with tested queen. Bees in frame-hives can often be purchased direct from owners; but for a beginner this involves some risk of getting disease or hives with poor combs to start with. It is usually the neglected hives which are for sale.

2.—*Swarms.*

Where starting with natural swarms, and new hives, all danger of introducing disease is avoided. Swarms are obtainable from the end of September to the end of December, at 10s. to 15s. each, according to weight, 2s. 6d. per lb. being the price usually charged by dealers, or they may be advertised for and bought direct from bee-keepers having a surplus. With swarms there is little danger of disease being conveyed, even though the bees come from a diseased hive. When obtained from a distance the boxes in which they are sent should be about the size of a kerosene case, with wire screen covering an opening of one-third of the surface on two opposite sides. The hives and frames should be bought beforehand, and be ready. When the swarms arrive they should be placed in a cool and well-aired spot till towards evening, when a cloth or bag is spread out in front of the hive entrance upon which the swarm is dumped out of the transit box. As a rule the bees will quickly run into the hive; if they

cluster outside without entering some should be brushed off with a large feather, and a little smoke used on all of them to start them running in.

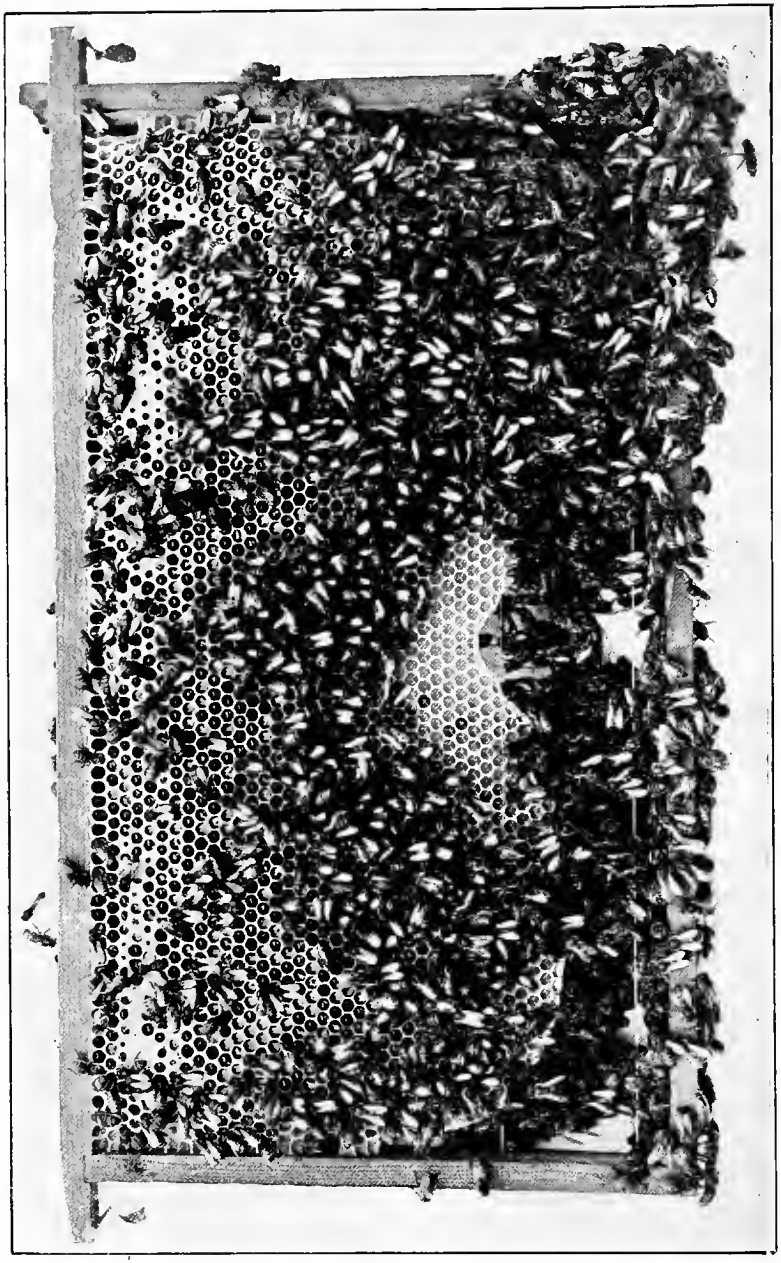


Fig 2.

If swarms are emptied out of transit boxes during the warm hours of the day or left hanging outside the hive overnight they will sometimes rise

and cluster in some inconvenient place, or may even abscond. If several days of inclement weather follow the hiving of the swarms, the bees should be feed with sugar syrup made by dissolving sugar in an equal weight of boiling water. This is given inside the hive in a wooden feeder supplied by dealers.

Single story hives, made up and painted, containing eight wired frames supplied with strips of comb foundation cost 10s. each, or if bought in the flat and nailed together and painted at home 8s. each. The hives when placed in position ready to receive the bees should stand perfectly level crossways to the frames, otherwise the combs may have the wires on the outside instead of in the centre, because comb is always built perfectly perpendicular by the bees. The hives should, if possible, be sheltered from the south, with entrances facing east, north, or west. When the combs are nearly down to the bottom bars of the frames (Fig. 2) a super or upper story must be put on. It may be of the same size as the lower one or of half depth with shallow frames. Unless full sheets of foundation are used instead of starters in the frames of an upper story a queen-excluding honey board (Fig. 3) should be inserted between the two boxes to prevent the queen depositing eggs in drone comb usually built from starters in the super. To start the bees building comb above, it will be necessary to hang a comb or two from the lower into the upper story taking care to leave the queen below and to fill the space below with a frame or two from above.

3. *Box-hives.*

Good colonies in box-hives or unworkable frame hives may sometimes be bought cheaply, and if free from disease the bees may be drummed up into a frame hive, placed, without its bottom board, on top of the inverted box-hive. If the combs containing worker brood are fairly straight they may be cut out and fitted into frames in which they are held in position by string tied over the outside of the frame. When these combs have been fastened to the frames by the bees the string may be removed, and when the colony is strong enough the combs may be hung in the super over a queen excluder till all brood is hatched, when they can be taken away and melted up for wax.

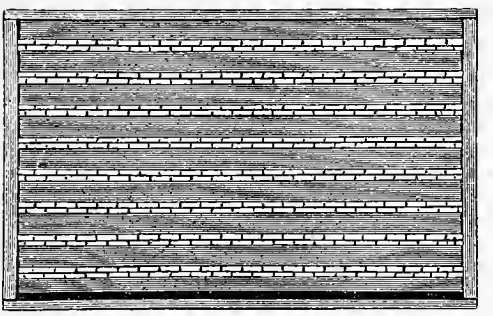


Fig. 3.

If a box-hive is strong and it is early in the season the most convenient way of transferring the bees to a frame hive is to let them swarm, hive the swarm in a frame-hive on the spot where the box-hive stood, and remove the latter some distance if it is desired to make two colonies; if not, leave it near the new hive but facing in a different direction. Just three weeks later all the worker brood in the box-hive will have hatched out, and a new queen will be laying. The bees may now be drummed out into another frame-hive or into the hive containing the swarm, as the case may be. The old box containing only combs without brood should be

taken indoors and secured against bees, and as soon as convenient the combs boiled down for wax. If there is any suspicion that a box-hive colony is diseased, it is best to drum it off at once, and destroy the box and old combs by burning. The bees themselves will be clean in their new hive provided they do not get access to any honey or comb from the old box after being driven off.

4. *Nuclei.*

Bee-keeping may also be commenced with nuclei colonies. A nucleus is a small colony of bees with a queen and two or three frames of comb with brood, and some stores. When received it is transferred to a hive and frames with starters or full sheets of foundations added to fill the box. Three-frame nuclei may be obtained of Italian bees at 15s. to 25s., according to the kind of queen chosen with them, and black or hybrid bees at 10s. to 20s., or either may be bought in full-sized hives with the additional frames in position for 5s. each extra. Under favorable conditions, if obtained early enough in the season, nuclei will rapidly build up into full colonies and have the advantage that the beginner is not troubled with hiving, and possibly losing swarms during the first season.

The first cost of hives, frames, and comb-foundation appears high, and many beginners think that money can be saved by making their own hives and frames. It will be found, however, that when timber of the proper quality is purchased in small quantities the cost per hive is very little less than that of one bought already prepared. In any case, it is advisable to purchase at least one hive and frames so as to have a pattern to work by. Californian red wood is decidedly the best timber for hives; it is free from knots, shrinks very little, does not warp, and is never eaten by white ants, which in some localities are very destructive to hives.

If the first cost has to be cut down to a minimum, temporary hives may be made out of kerosene or petrol cases. The frames which should be of the self-spacing kind (Hoffman) had better be bought, as they require to be made very accurately, so that later on they can be transferred to permanent hives. To construct a frame hive out of a kerosene case, one of the broad sides is taken off, while the opposite one serves as a floor for the hive. The original lid of the case is nailed on as a side, the former bottom of the case forming the other. At the bottom at one end an opening 6 in. by ⅜ in. is cut out as an entrance for the bees, and a strip of wood ⅜ in. thick (such as the thin boards of the case), is nailed to the inside of the ends of the case ⅜ in. from the upper edge. This is to suspend the frames from. A roof for this hive may be made out of the broad side taken off the case. It should, however, be covered with some waterproof material and shaded to prevent excessive heat melting the combs in the hives. Hoffman, or other full-depth frames should always be wired, as without wires new combs often break out in handling the frames, or fall down in hot weather. When two sets of half-depth or shallow frames are used wiring may be dispensed with.

If in making two shallow bodies out of a kerosene case, ¾ in. is cut off the ends of the case crossways before sawing it in two lengthways the resulting half-depth bodies will exactly fit on an eight-frame hive, on which it may be used as a super when a proper hive is adopted. A difficulty usually experienced by beginners is that, not wishing to purchase a honey extractor right away, they attempt to raise comb-honey in 1-lb. sections. It is well known amongst apiarists that the profitable production of section honey requires considerable skill and a good honey locality.

In the case of beginners both these factors are usually absent, with the result that the bees sooner than start work in the sections will repeatedly swarm, and the season will be over before the swarms have become strong enough to store any surplus of honey, whereas if frames had been used in the super instead of sections swarming would have been prevented to a great extent, and a fair amount of honey secured. With shallow unwired frames the honey may be obtained by cutting out the comb, leaving about ½ in. on the top bar to act as a guide for a new comb. The dimensions of shallow frames are:—Top bar, 19 in. long, 1 in. wide, ⅜ in. thick; bottom bar, 17⅝ in. long, 1 in. wide, ⅜ in. thick; side bars, 3¾ in. long, 1⅜ in. wide, ⅜ in. thick, nailed together as shown in Fig. 4.

Locality.

It must be understood that although bees may be kept almost anywhere, even near cities, and when properly managed some return may be secured,

Fig. 4.

no one should take up bee-keeping for profit or as a sole means of living unless prepared to go into the country as soon as the elementary knowledge and some experience in handling bees have been acquired. As wheat-growing is profitable only where fair-sized areas of easily tilled land are available, so bee-keeping requires a wide range of honey-producing flora to make it a paying occupation. To supplement the insufficient honey resources of a locality by growing flowers specially for bees is impracticable. The land available for this purpose in the neighbourhood of cities and towns is too limited in area, and too valuable. While in remoter localities where large areas of bee-pasture might be planted, the expense would be out of proportion to the return secured even if neighbours' bees and wild bees could be prevented from trespassing. Australia has such

a splendid honey-producing flora, if bee-keepers will only go to it, that there is no need whatever to raise plants specially for honey. In Victoria only a fraction of the nectar produced annually by our native flora is at present being gathered by bees.

VI.—Transferring Bees.

Owners of bees in box hives who wish to adopt the more profitable frame hive, or upon whom it has become obligatory to do so, can transfer their bees to frames by whichever one of the three methods described below best suits their circumstances. It may here be pointed out that the adoption of frame hives does not necessarily involve the purchase of expensive hives, honey extractor, and other appliances. Bees may be kept in home-made frame hives, and the honey taken by cutting out of the frames those combs which contain no brood and returning the frames to the hives to be refilled with comb by the bees. A strip of comb 1 inch wide should be left along the top bar of the frame; if this is cut to a V edge, very little honey will be left in the frame, and the necessity for putting a fresh strip of comb foundation into the frame is avoided, while yet straight comb building is insured.

Under the *Bees Act* 1910, the Governor in Council may proclaim districts in which bees may not be kept in other than prescribed hives. By a regulation under the Act, "Prescribed hive" shall mean any hive, the combs of which are in frames and capable of easy removal for the purpose of inspection. In a further proclamation certain districts are enumerated in which the transferring of all box hive bees to prescribed hives becomes obligatory.*

In order to effect the change with as little inconvenience as possible, hives with frames having starters (narrow strips) or full sheets of comb foundation fastened to the centre line of the top bars, should be in readiness so that all swarms which issue may be hived in such.

Transferring at Swarming Time.

When a swarm has settled (or clustered), it should be hived in an ordinary empty box, and, as soon as the bees are in, carried to the spot which the frame hive is to occupy.

Towards evening, when the bees are not likely to rise in the air again, the frame hive is placed in position, a bag or cloth spread out in front of the hive entrance in such a way as to provide an easy passage-way into the hive, and the swarm shaken or dumped out of the box on to the cloth. If the bees are slow in entering the frame hive or a considerable number remain outside, they may be gently driven in by blowing a little smoke on them; none, however, should be blown into the hive.

What to do with the box hive from which the swarm came will depend upon whether an increase in the number of hives is desired or

* The districts mentioned in the Proclamation are the Boroughs of Ararat, Clunes, Hamilton, Horsham, Port Fairy, Portland, Sale, Maryborough, Stawell, Talbot and the Shires of Arapiles, Ararat Avoca, Avon, Bairnsdale, Belfast, Bright, Colac, Dundas, Hampden, Kowree, Lexton, McIvor, Maffra Minhamite, Mortlake, Mount Rouse, Portland, Stawell, Strathfieldsaye, Talbot, Wannon, Warrnambool and Wimmera.

not. If no increase is wanted, the bees remaining in the old box may, after turning it open side upwards, be drummed up into an empty box placed on top (as in robbing box hives), and the bees thrown down in front of the frame hive containing the swarm.

The contents of the box hive may now be disposed of in the way usual with box hives. The combs will contain a considerable amount of brood (much more than when box hives are robbed at the usual time), and the many thousands of young bees, which would in the ordinary course have hatched within the following three weeks, may be saved if, instead of drumming the remaining bees off at once, this operation is deferred for twenty-two days, to allow all worker brood to hatch out. By this time there will be a young fertile queen, and the bees, after being drummed off, are hived on frames in the same way as the swarm, if increase is desired, or, if not, the old queen which went with the swarm may be removed from the frame hive and the driven bees with the young queen united with the bees of the frame hive by running them in towards evening after blowing a puff of smoke into the hive.

When re-uniting, as described, is intended, it is best to hive the swarm, in the first instance, on the spot occupied by the box hive from whence it came and place the old box alongside, with the entrance facing in a different direction from that of the frame hive. This will serve two purposes—first, the old bees which remained in the box after the swarm left it, when returning from their foraging flights, will go to the spot they are used to and join the swarm, with the result that no after swarm will come from the box hive; and, secondly, there will be no bees flying back after uniting, as would be the case if the new and the old hive were some distance apart.

Transferring at Robbing Time.

All hives do not swarm every year, and there may be a number still left in box hives when the swarming season is over. These may be transferred at the time usually selected for robbing by box hive bee-keepers. At this time, which varies in different localities and seasons, there is generally a maximum of honey and a minimum of brood, so that the saving of it is of no great consequence, and the transfer is best effected by robbing the boxes in the usual way, but putting the bees into frame hives instead of empty boxes. If any of the stocks are too small, two may be put together into one frame hive. As far as possible, adjoining boxes only should be united, otherwise the bees which had their hive taken away altogether will enter the hive nearest their old location. Hives which did not swarm during the season, and particularly those which are weak in bees, may be suspected of disease. The box should be raised on one side and a piece of brood comb broken out, the box lowered again, the comb taken indoors and carefully examined for foul-brood. This is done by removing the caps of some of the brood cells, especially those which look darker than the surrounding ones, and any that have sunken in instead of raised caps. This pricking open of the cells should be done with a toothpick, a wooden match, or straw. Healthy larvæ are of pearly whiteness and plump; diseased

ones are yellowish, grey, or brown, and flabby in appearance, and, later, collapse into a shapeless brown mass, which, when touched with a match, draws out stringy or ropy. This disease is often, but not always, accompanied by an odour of stale glue.*

Any colony found diseased and with not sufficient bees left to form a medium swarm should be at once destroyed by burning the box, bees, combs, and all. The bees should be shut in when they have stopped flying for the day, and the whole hive burned on a fire in a hole dug for the purpose, which is to be filled up with earth when everything is consumed.

If a diseased hive still contains sufficient bees to form a swarm, they may be drummed off into an empty box, in which they should be left for three or four days to cleanse themselves. The bees are then transferred to a frame hive like an ordinary swarm. The old box and contents should be burned as soon as the bees are driven out, and the intermediate hive cleaned by immersion in boiling water.

Robbing box hives for the purpose of transferring the bees to frames should not be done too late in the season, so as to give them a better chance to establish themselves before winter.

On no account should honey or comb, wax, or refuse from the box hives be given to the bees, nor should they be allowed to have access to it. The cutting out of combs, the straining of honey, and the rendering of wax should all be done indoors, secure from bees, or when that is not possible, it should be done at times when bees are not flying and all honey, wax scraps, or daubed utensils should be removed, or carefully and securely covered up, when the work is finished.

It may here be pointed out that the practice of many box hive bee-keepers of leaving comb too dark for the straining bag lying about straining honey out of doors, or even purposely putting scraps of comb and sticky refuse out for the bees to clean up, has, since foul-brood has been introduced to Australia, caused the loss of thousands of colonies of bees and the wholesale dissemination of that disease. Even the bees' nests in trees first became infected in this way. The subsequent felling and robbing of bee trees by bee hunters, who left the refuse exposed to other wild bees, box hive, and frame hive bees, caused a still wider distribution of foul-brood.

It is not natural for bees to find honey. They gather nectar from the blossoms; this they transform into honey inside the hive. When they find honey outside they become excited; when the supply is exhausted they forage around for more; they find weak, usually diseased colonies, or bee trees, somewhere within their range of flight; they attack these and carry home their stores of honey, and with them the germs of foul-brood.

If feeding bees is necessary, as it may be in the case of late transfers, sugar syrup (2 sugar to 1 boiling water by weight) should be given in a feeder inside the hive, not honey outside. Sugar syrup does not excite bees so much as does honey, and can be relied upon as being free from disease.

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* For symptoms of Foul-brood and its treatment see Chapter XIX., page 79.

Transferring Bees and Combs.

Any one who understands bees well, and has sufficient experience in disease to enable him to detect the very first trace of it, can transfer box hive bees to frames at any time during the active season by cutting out any of the combs of brood in the box hive which are straight enough and fitting them into frames. The pieces of comb are held in position either by means of string tied over the frame and comb, or thin splints of wood tacked to the frame. These temporary supports may be removed as soon as the bees have fastened the combs to the frame. It is seldom that more than two or three frames can be filled with brood from a box hive; the rest of the frames are supplied with starters or full sheets of foundation. As the bees become established on newly-built combs the frames of transferred combs are gradually worked to the outside of the cluster of bees, or put into the upper story over a queen-excluding honey board, and when all the brood is hatched out of them they are best withdrawn from the hive and melted for wax.

While this method saves most of the brood and transfers everything in one operation, it is a very messy one. There is always a risk of transferring disease to the new hive along with the brood or comb, and the transference of brood and comb should, therefore, not be undertaken by any one not possessed of the requisite knowledge and skill.

Note.—Price list of hives, frames, appliances, &c., may be obtained from W. J. and F. Barnes, 550 Swan-street, Burnley, or The Beekeepers Supply Company, 459 Swanston-street, Melbourne.

VII.—Spring Management of Bees.

During the first or second week of September, all hives should be examined for the purpose of seeing whether each one has sufficient food, a laying queen, and enough bees to enable it to work up into a profitable colony.

This examination should be made only on fine mild days, otherwise harm will be done to weak stocks, by letting the warmth escape when opening the hive and by causing the bees to fly and become chilled. Having lighted the smoker, blow one or two whiffs of smoke in at the entrance, lift the cover at one end, and blow a few puffs of smoke over the top of the frames. When quilts are used between covers and frames, hives can be opened with less disturbance, less smoke is needed, and it is consequently easier to find the queens.

The amount of stores is the first consideration of this time of year, but no hard and fast rule can be laid down as to the actual weight of honey required to maintain and develop the colony. The quantity depends upon the number of bees in the hive, the length of time which may elapse before they can find sufficient new nectar in the blossoms of the immediately surrounding country, and the weather conditions prevailing during the following four or five weeks. In no case, however, even under the most favorable circumstances, should there be less than 5 lbs. of honey (equal to one well filled Langstruth comb) in the hive. Bees build up in spring on their winter stores, excepting in specially favoured localities with a mild climate and an early flowering flora.

From 15 lbs. to 25 lbs. of honey is more like the quantity required in an average locality to obtain the best results in brood-rearing till sufficient new nectar is available from outside sources. As the consumption greatly increases as soon as brood-rearing commences, any shortage should be made good by feeding sugar syrup. (See Chapter XVII., page 72.)

If no feeders are on hand, a clean empty comb may be filled with syrup by placing it flat in a milk or other suitable dish and pouring the syrup into the cells from a height of about 15 inches. When one side is filled, the comb is turned over and the other side filled. To get a fine stream of syrup, a jug with a rather pointed lip is the most suitable vessel. When the comb is filled, it should be held or suspended over the dish for a short time, to allow the surplus syrup to run off. The latter would otherwise fall on to the floor of the hive, and in all probability attract robbers.

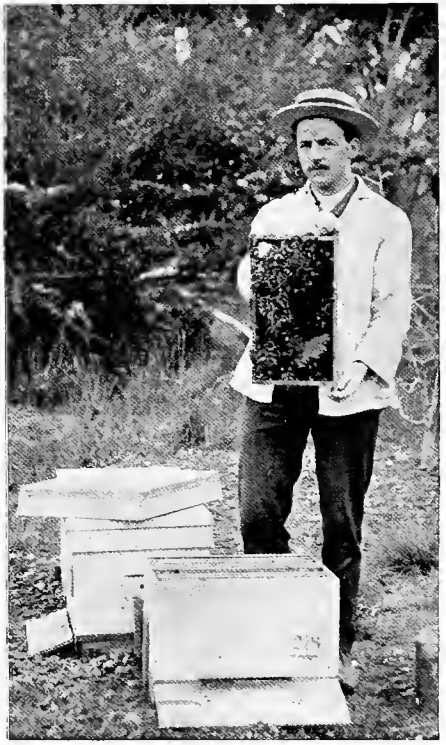
Every hive should have a fertile queen; and, as a minimum, bees on at least two or three combs. It is not absolutely necessary to see the queen, the presence of eggs and of brood in the several stages being sufficient evidence that the queen is all right. When the eggs, however, are at the side of the cell bottom, and not in the centre, laying workers instead of a queen may be present.

A further indication of laying workers, an unfertile young queen, or an exhausted old one, is that the cappings of the sealed brood, instead of being only slightly oval, are hemispherical and project much beyond the general surface of the comb. This is due to the fact that the eggs of laying workers and unfertile or exhausted queens produce drones only. The larvæ of the latter are larger than those of the workers, and being in worker instead of in drone cells there is not sufficient depth and the cell is therefore lengthened in capping it. If a hive in this condition still contains sufficient bees, and is to be retained as a separate stock, the laying workers or the drone-laying queen must be replaced with a fertile queen. With Italian bees, which are quieter than blacks, and the queen differently marked from the workers, she is usually easily found. Black queens are often very hard to find on account of their sombre colour and the habit of black bees of clumping or running off the combs when disturbed.

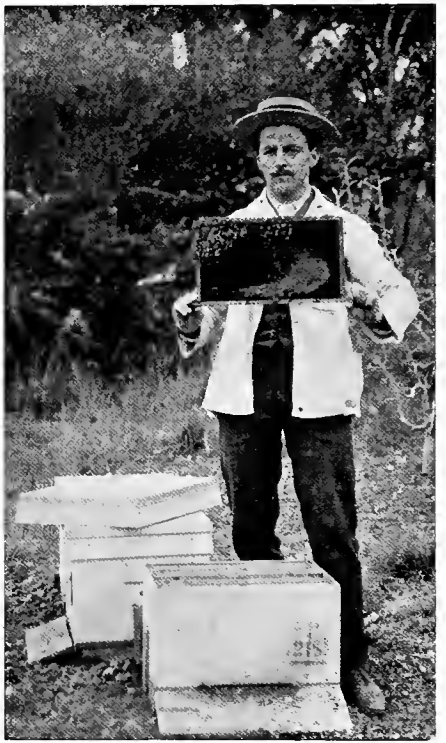
Correct Way of Handling Combs.

In hunting for queens, or examining brood for disease, it is necessary to see both sides of each comb. To do so, many bee-keepers turn the comb in the wrong way, resulting in a fracture of the cells near the top bar when the comb is not built right down to the bottom bar and it is at all heavy with honey. It also causes spilling when the comb contains new thin honey. A comb should never be turned on a horizontal, but always on a vertical axis. Combs fractured or strained through handling them the wrong way often mash up in the extractor. When the combs are returned to the hive the bees repair them; but, as the damaged cells, become elongated through the weight of the comb, they are large enough for drone-brood, several rows of which will be found across the comb where it was fractured when the comb is used in the

1. First Position.



2. Second Position.



3. Third Position.

Correct Way of Handling Combs.

brood-chamber. Combs so damaged are also very liable to come down in hot weather or in moving bees by road or rail.

If combs are handled the right way, no harm will be done to them, even when built from starters and not fastened to the bottom bar of the frame. As bees generally, and queens in particular, run to the bottom of the frame when it is lifted out of the hive, it often becomes necessary to turn the frame upside down when looking for the queen. In Fig. 1 is shown the first position; to turn the frame upside down without damaging the comb the top bar of the frame is brought into a vertical position as shown in Fig. 2; and by swinging the frame half-way round (like a door on its hinges), and then bringing the top bar into a horizontal line, the frame is completely reversed as shown in Fig. 3. As the bees again travel downwards, the queen, if she is on the particular comb, will be noticed. To turn the comb to the hive, the same movements are again gone through, but in the reverse order of 3, 2, 1.

If, in the course of the first examination, one or more colonies are found with unfertile queens, the hives should be marked and left alone till the overhaul of all of the colonies is completed. Amongst a number of stocks of bees there are generally, at this period of the season, some which are weak in bees, though possessing a fertile queen. These queens may with advantage be used to replace unfertile ones in colonies with more bees. To transfer a queen, it is first of all necessary to find and remove the one which is to be replaced. The following day, preferably towards evening, the small stock with the fertile queen is placed alongside. Both lots are gently smoked, and the combs with brood and bees from both put into one hive, so that each comb from one is between two from the other hive. The outside combs of both are put into the other hive body which is placed on top of the first, the bees brushed off the combs, and the latter and the hive body removed. If uniting is done later in the season, the second body and combs may be left on as a super.

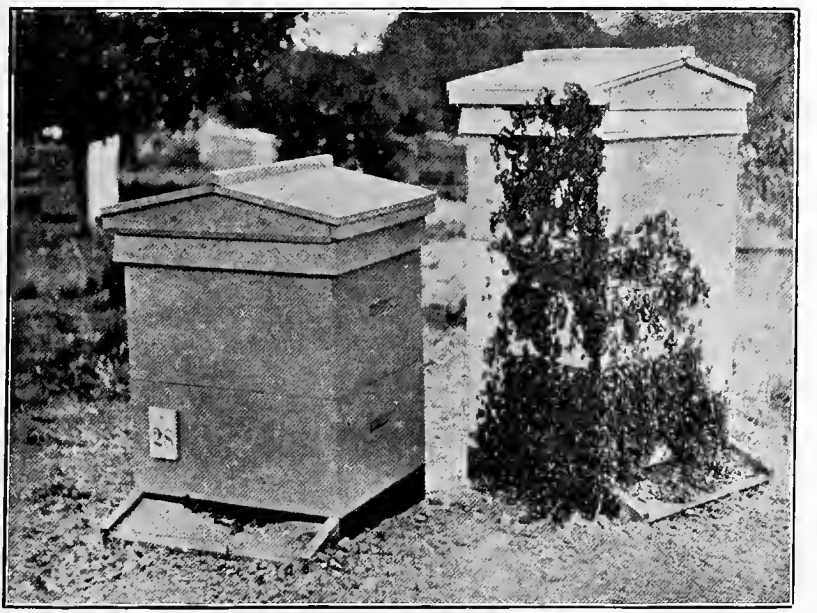
When no small stock with a laying queen is available, a colony with an unfertile queen may be kept going by giving it a comb of eggs, or young larvæ from a normal colony, once or twice a week, according to the number of bees. At the same time, remove one of the combs of drone larvæ and substitute it for the comb removed from the normal colony, which will usually throw out this useless brood. In this way a colony may even be gradually built up; and, when young queens are available from swarmed stocks, the valueless queen can be replaced.

It is often very difficult to get a colony with laying workers to accept a queen, all the bees being old; but, if treated as described, there will soon be a sufficient number of young bees, and the introduction of a queen may then be safely accomplished. Colonies found queenless, and without even laying workers, should be dealt with in the same way, if still sufficiently strong enough to be worth saving.

A mistake, often made by beginners, and even by established bee-keepers, is the spreading of brood with the idea of hurrying brood-rearing. This practice of putting empty combs, or even partly filled ones, between the brood combs, more often results in loss than in gain. It is recommended in some of the text-books written for countries in which the sudden changes of temperature experienced here do not

occur. During September and October, colonies have all the brood they can cover on a cold day, and spreading the combs by putting a vacant one in the middle, results in the brood in some of the outside combs perishing from chill. If it appears necessary to give room for brood, the combs should be placed, one at a time, alongside, and not between, the brood.

Under normal conditions, a colony of bees increases rapidly in strength during September and October. As soon as all the combs of the brood chamber are occupied by bees, and before they are actually crowded, the second or upper story should be put on and the bees induced to commence work in it. This is done by taking a comb containing honey from the brood chamber and putting it into the second story and directly over the brood combs, while the frame from the



Swarm Returned after Losing the Queen.

upper story is placed into the brood chamber. When a colony of bees has become crowded before the super is put on, it will quite likely be inclined to swarm, and no amount of manipulation will cure it of that tendency till the swarming season is over. When bees are worked for extracted honey there is much less swarming than when comb-honey is produced.

If a maximum profit from the number of colonies kept is aimed at, the raising of comb-honey in 1 lb. sections should not be attempted in any locality which has not at least a fair honey flow. Many owners of bees find it very difficult to induce bees to work in the section supers. There are various reasons for this disinclination of the bees to enter sections. Bees at any time prefer to work together in large numbers

and without any break in the combs in a vertical direction, and are therefore disinclined to work at comb-building in such comparatively small clusters as the 1 lb. sections necessarily create. Further, the sections are, in many instances, supplied with very small starters of foundation, leaving a distance of 3 inches from the brood-combs to the lowest point of the starter in the section. Bees invariably store their honey just above the brood; and, instead of commencing comb-building on the small starters in the section so far away from the brood and separated from it by empty space and the woodwork of the section, they frequently store the honey they gather into the cells from which young bees emerge. This restricts brood-rearing and causes the crowding of bees in the brood chamber, which is such a fruitful source of excessive swarming.

This difficulty may be overcome by inducing the bees to enter the section, or by compelling them. Bees may be induced to enter the section super by putting on one or more sections already partly built and containing some honey amongst the empty ones in the super. These partly filled sections are known as bait sections. When none are available, the bees may be compelled by first putting a super of full-sized frames of empty combs; or, failing this, of full sheets of foundation on the brood-chamber. If there is sealed honey along the top bar of the brood combs, the cappings of the honey may be lightly scratched with a fork, which will induce the bees to remove it and the queen to deposit eggs therein, thus bringing the brood right up to the top bar. When this stage has been reached, the bees may be brushed off the combs of the upper story and a section super put in its place. As there is now brood in the combs of the hive right up to the top bar of the frames, and as the bees want to place honey above this brood, they will, as a rule, at once commence work in the section, provided that honey is coming in.

The upper story removed from the hive may be used on another hive for a similar purpose, or as an extracting super. If it contained brood at the time of removal, the largest sheets of it may be put into the brood-chamber. Removing from the latter any combs containing little or no brood, the object being to crowd into the lower story of the section hive as much brood as possible so as to leave no room for honey. Keep the colony strong, and compel the bees to build comb and store honey in the sections. Any brood left over may be given to weaker colonies, but only as much as can be taken care of by each.

As October is the principal swarming month, a watchful eye should be kept on the hives from 10 a.m. to 3 p.m. on fine days, unless the condition of the colonies in regard to the swarming tendency is known, from a record of the ages of the queens and systematic periodical examinations to see whether swarming preparations are in progress.

While it prevents the absconding of prime or first swarms, the clipping of queens often causes trouble through the queens getting lost. The swarm returns to the hive, only to issue again, a week or so later with a virgin queen and a greater number of bees. As a virgin queen is light and has greater powers of flight, such swarms will usually settle high up in inaccessible places or abscond without clustering. It is, therefore, not advisable to clip queens, unless the hives

are near a dwelling from which a view of them can be obtained, or the number of colonies is sufficient to keep a special watch on them during swarming hours. The illustration shows a hive to which the swarm has returned after losing the queen.

VIII.—Swarming.

Swarming is a natural impulse with bees, and the means of multiplying the species. In Victoria it occurs from September till December, October being the principal swarming month in most localities.

In abnormal seasons, when copious rains succeed a period of drought, swarming may take place a second time in January or February.

To the beginner the issue of swarms is a source of delight, and the most convenient way of increasing the number of his colonies. When, however, stocks have increased to the number intended to be kept, or to what the locality will carry with profit to the owner, then swarming becomes a trouble, involving a considerable amount of unprofitable work, and unless it is counteracted by re-uniting of swarmed stocks may result in the loss of all surplus honey. This is particularly so in districts having a plentiful supply of pollen in spring and a honey flow in early summer only. Taking as an illustration two colonies of equal strength, and assuming that one swarms several times, and that the other does not swarm at all, the worker force of the former is broken up into two, three, or more communities, none of which is in a condition to store surplus honey for a month or longer, because the parent colony is depleted of field bees by the issue of one or more swarms. The young queen, hatched after the swarm left, does not commence to lay for fourteen to twenty-one days, and this interruption in the succession of bee generations seriously affects the storing of honey later on, while every swarm put down in a separate hive has first to build sufficient comb to fill the frames of the lower story, establish a brood-nest, and accumulate stores before it is in a condition to store surplus honey. This point, at which productiveness commences, is in some localities, such as the country surrounding Melbourne, not reached till the main honey flow is practically over, and for the remainder of the season the bees are only able to gather sufficient to maintain themselves, and sometimes not enough to last them through the winter. In the following season the colonies which survived will again undergo division by swarming, little or no honey will be obtained, and the owner will come to the conclusion that bees are not profitable in his locality. It should be understood that increase of colonies always takes place at the expense of honey production, except in exceptionally good bee-country, with a late honey flow; but in passing it may be mentioned that in Spring bees are as much a saleable commodity as honey, that apiarists in the best honey districts of the State purchase swarms in large numbers, and that in localities better suited to the breeding of bees than the production of honey better profits may be obtained by the sale of bees than of honey.

Taking now the case of a colony which does not swarm at all, although of the same strength as another one which does, it will be seen that as the laying queen remains in the hive there is no interruption in the rearing of bees, and as all the work which is done by swarms during the first three

or fours weeks is done by bees which come from the parent colony, it follows that when the total worker-force remains in the parent hive whatever would be needed in the establishment of the new colonies is available as surplus; in other words, the nectar available in the flora of the locality is, in one instance, turned into surplus honey for the benefit of the owner of the bees, and in the other into more bees which cannot do more than exist for the remainder of the season.

What has been said so far does not apply to the best honey districts of this State where the honey flow is heavy, and more or less continuous for the greater part of Spring, Summer, and Autumn; but even when the limit to increase is one of labour and material rather than of sources of nectar it is found more profitable to have the same total force of bees in a lesser number of colonies. More surplus can be obtained from one colony containing 30,000 bees than from two containing 15,000 each, because the number necessary to attend to domestic work such as the rearing of brood, carrying water, &c., is practically the same in the smaller as in the larger colony, the latter has therefore a much larger number of bees available for the gathering of nectar and is less influenced by changes of temperature.

The prevention or control of swarming is one of the most difficult problems of bee culture. Systematic efforts to eliminate the swarming impulse by breeding all queens from the mothers of non-swarming stocks have so far only resulted in reducing the percentage of swarming, owing to the inability of queen breeders to control the mating of the sexes as is done in the case of animals and birds. Beekeepers are therefore compelled to confine their efforts to cope with the swarming problem to the removal of contributing causes and to counteracting the effects which swarming has on honey production. Apart from the natural impulse, which is much stronger in some races, some strains, and even some individual colonies of bees than in others, climate, season, and flora have great influence upon the swarming propensity. These are factors beyond the control of the beekeeper; there are, however, others which may be controlled, more or less, and excessive swarming prevented thereby. The principal inducements for bees to swarm are—

1. A crowded condition of the bees.
2. The presence of large numbers of drones.
3. An old or failing queen.

1. Hives may become crowded with bees early in September if wintered in single stories; as soon as the bees occupy all the combs, an upper story, with drawn empty combs, should be put on to allow the bees to spread out as their numbers increase and the weather becomes warmer. The beginner is at a great disadvantage in not having another set of combs, and the only thing he can do is to remove one or two combs from the brood chamber to the super (upper story) and put two frames with full sheets of foundation alongside the outside brood combs in the lower hive body. The bees will soon draw the foundation into comb, and the combs removed to the super will induce them to commence work there. Frames with starters only should not be used before swarming time, as drone comb is invariably built in them at this period. It must be pointed out that the addition of a set of frames with starters, or a section super, does not spread the bees out, because there is no connexion between the brood combs and the starters in the super. In a wild bees' nest, or when a set of drawn combs are given, the comb is continuous, and therefore, in the

latter case, accepted by the bees as part of their home as soon as required and the crowded condition relieved.

2. The presence of large numbers of drones is best avoided by the use in the brood chamber of combs built from full sheets of foundation, or combs which have been built by swarms during the first three weeks. The cutting out of drone comb or the shaving off of the heads of drone brood is of very little use, because drone comb is again built by the bees in the same space, and the queen again lays drone eggs into the cells from which the bees have removed the decapitated drones.

3. Old or failing queens may be discovered during the first or second examination of hives in Spring (Fig. 1) by noting the irregular way eggs are laid, as they are found scattered about instead of in compact circles. Colonies having three-year-old queens will be found most inclined to swarm; those with two-year-old queens less so, and the previous season's

Fig. 1.—Spring Examination of Hives.

queens still less, while later on, when young queens of the same season's rearing are laying, their colonies will not swarm the same season. Defective and old queens should be replaced as soon as ripe queen cells are available. In weak colonies the queen may be destroyed and a queen cell given at the same time, the interruption of brood rearing can be made good by giving a comb of brood a few days after the young queen hatched. If the colony contains sufficient bees it may be divided into two on the same stand, the old queen being kept laying in one till the young queen is laying in the other, when the former may be removed and the two stocks united by alternating the brood combs after smoking both. Uniting is best done at or after sunset.

Even when everything possible has been done to discourage swarming, there will be a number of swarms, but they will be larger (Fig. 2) than

they would have been had the colonies swarmed earlier. Examining the hives once a week and destroying any queen cells that are found will, to some extent, prevent swarming or, at any rate, delay it. However, unless the bees are shaken off the brood combs every time, a small queen cell on the face of the comb, or one well covered with newly-built comb, is very likely to be overlooked and, if conditions continue favorable, colonies which have been thwarted will often swarm without having built cells. Taking into account the trouble involved by a careful weekly examination and the risk of failing to prevent swarming, it will be found best to allow the swarm to come off and, if no increase but a yield of honey is desired, to re-unite the swarm and the parent colony. This is done in the following manner:—When the swarm has issued and clustered somewhere, hive it in a new box on a set of wired frames with starters on the spot occupied by the hive from which it came; remove the latter a little to one side, with the entrance facing at right angles to its former position. All flying bees remaining in the parent stock, on returning from the fields, will join the swarm, because they will return to the spot they are used to. The swarmed colony will thus be so depleted of flying bees that usually the first virgin queen which hatches from one of the cells will be allowed by the bees to destroy the remaining queen cells. To make sure, however, that no after-swarms come off, it is best to examine the stocks within a day or two and destroy all the queen cells except one, selecting for the purpose one of the largest and most forward in development. In from fourteen to twenty-one days the young queen will be laying and, under normal conditions, the combs in the hive containing the swarm will have been built down to the bottom bar of the frames. In the meantime the parent hive has been gradually turned round till it stands close alongside to the swarm, with the entrance facing the same way, and the two stocks may be united into one hive, the old queen (that with the swarm) being removed, the young queen taking her place on the new combs, with the old combs over a queen-excluder in the super to be extracted when full, or replaced by frames with full sheets of foundation, if unsuitable for further use.

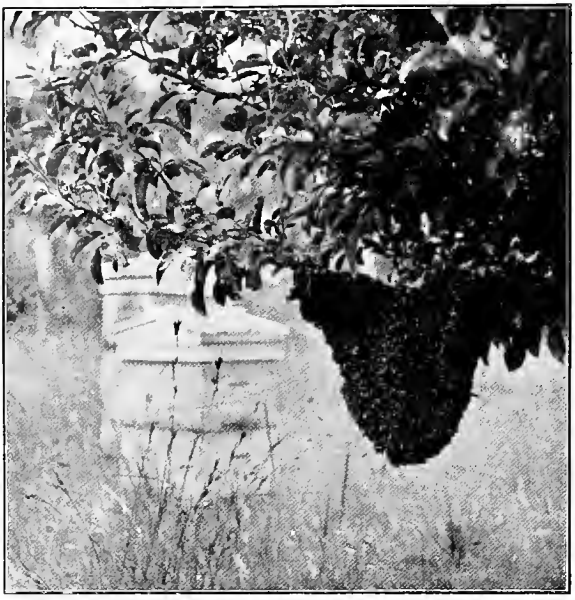


Fig. 2.—A Large Swarm, 10 lbs., or about 45,000 Bees.

As previously stated, uniting should be done towards evening, first blowing smoke between the combs of both colonies, and then alternating

the frames of the two colonies, thus thoroughly mixing the bees. They will have settled down by next morning, and will work peaceably together; the combs intended for the brood nest and the queen are then put in the lower chamber, the other combs in the super above a queen-excluder.

The old queen may be removed the day before uniting, which should not be attempted till the young queen has been laying for some days, as much stinging and balling of the queen may take place if uniting is done before or too soon after the young queen commenced laying.

The united stock is in the best condition for storing surplus honey, the brood combs have been renewed, and the queen being of the same season's raising, there will be no further swarming.

IX.—Honey.

Honey is the nectar of flowers which has undergone chemical changes during and after the gathering by the bees.

It is composed principally of two sugars, dextrose and levulose, and water. Several other sugars are also usually present, as well as formic acid, tannic acid, albumen, and the essential perfumes of the blossoms from which the nectar was gathered. It is the presence of these essential oils which produces such a great variation in the aroma and flavour of different honeys. All honey is liable, sooner or later, to candy, or granulate; it becomes first cloudy and gradually partially or wholly solid.

Of the two principal sugars composing honey, dextrose is a crystallizing and levulose a relatively non-crystallizing sugar, and the preponderance of the one or the other governs the rapidity and degree of crystallization; while the variation of the greater quantity of one or the other is due to the flora from which the nectar was gathered by the bees. There are, however, some other minor factors which hasten or retard granulation. These are temperature, amount of water, pollen grains, and air bubbles. Honey does not as a rule granulate till the approach of cool weather, and that gathered during cool weather granulates sooner and firmer than honey produced in midsummer. Any honey, however, will granulate sooner under frequent changes of temperature than when kept at a uniform degree, high or low.

The amount of water present in honey varies according to the source of the nectar, the humidity of the atmosphere at time of gathering, and the length of time it remained in the hives. In Victorian honey it ranges from 12 to 20 per cent., the average density being 15 to 17 per cent. When exposed to the atmosphere, the percentage of water will adjust itself to the humidity of the air; thus honey from the dry districts of the State, unless kept hermetically sealed, absorbs water from the air in the city sale-rooms and becomes quite thin on the surface during moist weather. As water is necessary to crystallization, the thinner honeys naturally granulate more readily than the dense honeys from dry districts. Some of the latter remain liquid for one or two years. Particularly is this the case with yellow box and red box honey, which, if it could be obtained entirely free from admixtures of other kinds, would probably remain liquid indefinitely.

Pollen grains, which are always present in honey, have no doubt some influence in the granulation by acting as nuclei of crystallization. At any rate, it is certain that the honey from plants producing abundance of pollen for bees, such as the redgum, grey box, and stringybark eucalypts, and white clover, cape weed, and native dandelion, granulates very quickly; while that from yellow and red box, producing little or no pollen for bees, remains liquid for a long time. When the modern method of removing the honey from the combs by centrifugal action was first adopted, it was soon found that the air bubbles incorporated in the honey by this process caused it to granulate sooner than when the old method of crushing the combs and straining was practised. How to remove this incorporated air, and to delay granulation generally, will be dealt with in a succeeding chapter.

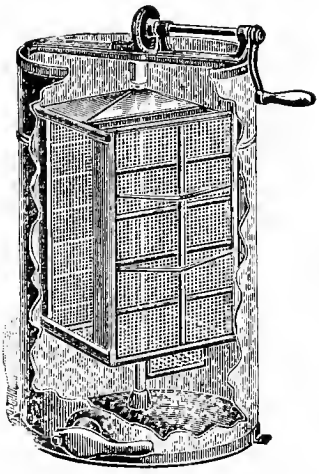


Fig. 1.—Novice Extractor.

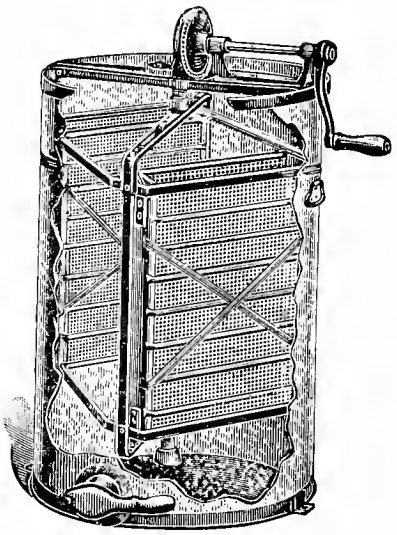


Fig. 2.—Cowan 2-Frame Extractor.

Extracting Honey.

Extracting the honey from the combs is in itself a simple enough operation, consisting in first slicing the wax cappings off the sealed honey-comb by means of an uncapping knife, then placing the frames, two, four, or more at a time, upright into the comb-baskets of one or other of the various styles of honey extractors, when by turning the crank handle the baskets are revolved round a central shaft inside a tin can, and the honey is thrown out from one side of the comb against the side of the can by the centrifugal force produced. The combs are then reversed; in the smallest kind of extractor (The Novice), as shown in Fig. 1, the combs have to be lifted out and re-inserted with the opposite side facing out. In the Cowan two-frame extractor (Fig. 2), each of the comb-baskets is swung round without removing the comb; while in machines of four or more comb

capacity the baskets are connected by a sprocket chain (Fig. 3), and the reversing of one will reverse all the combs. In the latest type of extractor the reversing of the driving gear automatically reverses the combs. In large apiaries in the best honey districts petrol engines are used to drive the extractors, the reversing action being obtained by means of the slip gear, which causes either the one or the other of the bevelled cog wheels seen on top of the extractor in the illustration (Fig. 4) to grip the horizontal cog of the centre shaft, and thus drive the reel with the comb-baskets in either a right or left hand direction, the comb-baskets being automatically reversed at the same time. By using a power-driven extractor, cappings melter, honey ripener, and a system of gravitation from the extractor to the settling tank, three men can easily take 1 ton of honey in a day of ordinary working hours. As it often happens during heavy honey flows that there are days when, owing to strong wind, extreme heat

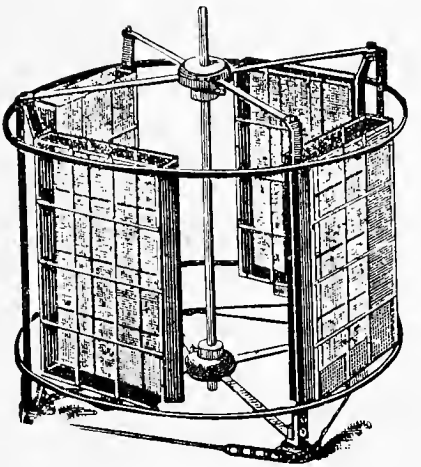


Fig. 3.—Reel of Four Comb Reversible Extractor.

or cold, no honey can be taken off the hives, and yet the bees continue to bring it in notwithstanding these drawbacks, it becomes necessary to get a maximum of extracting done while conditions are favorable for this operation, so as to provide storage room for the bees and to prevent them gluttoning the brood combs with honey. With several hundred colonies in a good locality, the additional yield obtained will more than cover the cost of engine, reducer, honey heater, &c., in one season.

For apiaries of up to 100 colonies in ordinary average localities, a Cowan two or four frame extractor, driven by hand (Figs. 2 and 3), will be sufficient. When only a few colonies are kept, without any prospect of increase owing to the character of the locality, a Novice extractor (Fig. 1) will answer all requirements. To any one, however, commencing bee-keeping anywhere with the intention of gradually increasing the number of hives and moving to a suitable

locality I would recommend obtaining a two-frame Cowan reversible at the start, as the difference between it and the Novice is not more than 10s. to 12s. 6d.

Whatever kind of extractor is used, the same general rules will apply; but it should be borne in mind that the smaller the diameter of the extractor the faster it has to be turned to remove the honey from the combs, and the more liable are the latter to fracture, because the nearer the comb is to the centre shaft the more divergence there is in the direction of the centrifugal force acting on the comb at different points.

When inserting uncapped combs into the extractor-baskets or withdrawing empty ones, it should be done without brushing against the wire screen, otherwise the cells will become burred, preventing

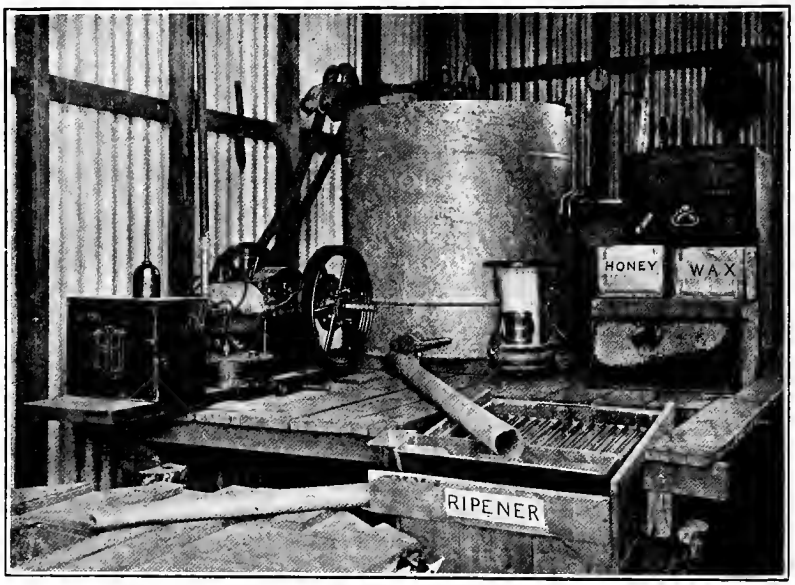


Fig. 4.—Extracting Plant of Large Modern Apiary.

the honey coming clean out of the cells, and causing unnecessary work to the bees. This bruising of the cells will also occur in uncapping the combs when the combs are tough and the knife blunt. The uncapping knife should be as sharp as a razor. Extracting combs should be straight, and present an even surface after being uncapped, so as to rest evenly against the wire screen of the extractor-baskets.

Before extracting is commenced the honey should be properly ripe.

Unripe honey is inferior in density and flavour, granulates sooner, and, when too thin and containing tannic acid, will even become very dark when it comes in contact with iron. Most Australian honeys contain tannic acid in traces; but, when properly ripe, the acid does not act on the iron of the tins. No general rule can be laid down

as to when honey is ripe; it depends upon the source from which the bees gather the neetar and the degree of humidity of the atmosphere at time of storing by the bees.

While honey from different plants varies considerably when fully ripe in the percentage of water it contains, ripe honey from one and the same source, but gathered in different localities, or even in the same locality but under different atmospheric conditions, will contain water in varying proportions.

During the summer months, in districts north of the Dividing Range which have a rainfall not exceeding 30 inches, honey is considered ripe when the combs have one-half to two-thirds of their surface capped over by the bees. In the country south of the Divide, and in districts with a heavy rainfall, it is better to leave the combs

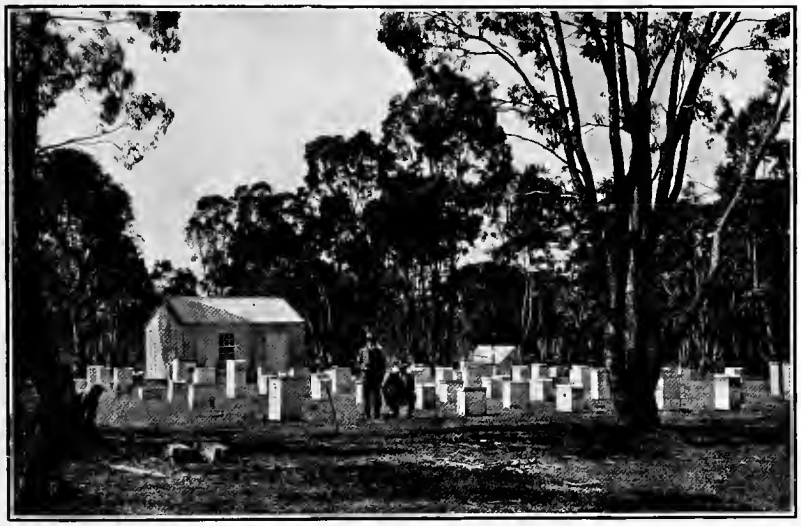


Fig. 5.—An Apiary in Ideal Bee Country.

on the hives till nearly capped all over. This also applies to the northern districts during early spring and late autumn.

On the other hand, during very dry weather honey may become over-dense and difficult to extract, even when not sealed. This sometimes occurs when a cold change, without rain, follows hot weather with a good honey flow. It is always best not to take off honey when the weather is cold, unless it is unavoidable. The combs must then be stored, and the extracting done in a warm room.

Beginners often have difficulties through damaging the combs whilst in the extractor. This may result from several causes; the honey in the combs may have been too cold, the extractor may have been turned too fast at the start, the combs may have been too warm and soft, or the frames may not fit evenly against the wires of the extractor-baskets.

It must here be pointed out that there is at least one kind of honey which cannot be removed from the combs by extracting; it is that gathered from one of the tea-trees (*Leptospermum scoparium*) found near the coast and in wet places elsewhere. In some localities it is known as wild may. The honey from this plant is very dark, strong-smelling, and rank in taste, and fit only for manufacturing purposes. The class of country producing this kind of honey should be avoided by bee-keepers. When, however, it occurs in belts in some of the best redgum and box districts, it provides a valuable stand-by for the bees during the "off" season. This honey, although it appears very dense, really contains a high percentage of water, but after being stored in the cells it sets like jelly, so that it can be removed with a pin in one piece. The only way of getting it from the combs is to cut them out, and melt and separate in a cappings reducer; better use can, however, be made of it by reserving it for the bees as winter food, provided that it is not the only crop of the locality.

Honey from the red box eucalypt is very dense, and it is almost impossible to extract it without damaging the combs once it has been allowed to become cold in the combs. In a lesser degree this may also be said of yellow box honey. To extract dense honey without damaging the combs the extractor should be turned slowly till about half the honey of one side of the combs has left the cells; the combs are then reversed and the speed increased till that side of the combs has been emptied. Then the combs are again reversed, when the honey left in the cells on the other side is thrown out.

X.—Uncapping Combs.

Before the honey can be extracted from the combs of the modern frame hive, the wax caps with which the bees have covered the cells of honey have to be removed. This is done by means of what is known as an uncapping, or honey, knife—a stout knife 8 to 12 inches in length with two cutting edges, bevelled from one side, and an off-set handle. To uncap quickly and without damaging the combs, the honey knife should be as sharp as a razor and must be kept in hot water so that it will easily pass the comb surface on one side and the sheet of cappings on the other. Two knives may be used with advantage, so that while the operator is working with one, the other is getting hot for the next comb. There are several different knife-heaters, one of which, seen in the illustration (Fig. 3), is heated by a small lamp. When a cappings melter is used, a separate knife-heater is not required, the knives being hung into the hot water of the apparatus as shown on the left in Fig. 2.

The uncapping of the combs and the extracting of the honey should be done as soon after the combs are taken from the hive as possible, if the weather is at all cool, unless a warm room is available in which to keep them. Combs uncap and extract best at the temperature they are in a hive crowded with bees.

There are different ways of uncapping combs, cutting upwards or downwards, crossways of the frame or lengthways; but in each instance the bevelled edge of the knife is towards the comb, the severed cappings passing over the broad face of the knife. The majority of operators use

the upward stroke; the frame is placed on end over the cappings receptacle, the knife is started at the lower side bar of the frame and with a slightly sawing motion drawn upwards, the top and bottom bars of the frame acting as a guide to the bevel of the knife, if a long one is used. To prevent the severed cappings falling back against and sticking to the surface of the comb, the frame should be tilted slightly forward, as in Fig. 2. Before returning the knife to the hot water it should be drawn across the edge of the wooden frame support to free it of honey and wax. The hand holding the frame should be kept back behind the wood of the

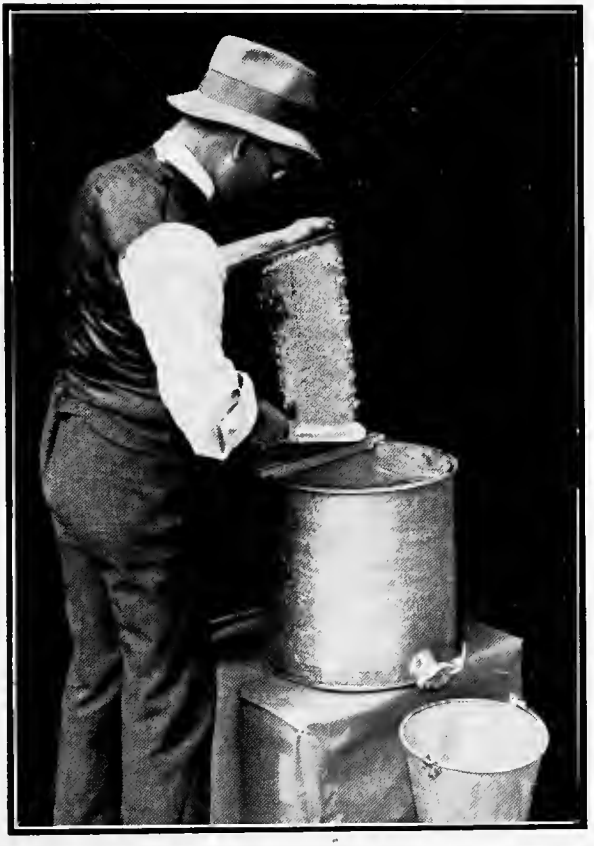


Fig. 1.—Uncapping Combs into Simple Melter.

frame, as in Fig 1, to prevent cutting it should the knife slip at the end of the cut. Uncapping, as in Fig. 3, is likely to result in damage to one's fingers. To keep the honey knife in good order, the edge used for uncapping should not be utilized for trimming burr combs off top or bottom bars where nail-heads are likely to be met. The knife should not be left in the heating water during intervals in the work; and when being sharpened should be ground from the bevelled side only, and brought to a fine edge with an oil-stone.

A receptacle into which the cappings drop as they are shaved off the combs is necessary. The simplest form consists of a vessel with a perforated bottom through which the honey drains into a lower receptacle. For larger apiaries a trough, with a perforated false botton an inch above

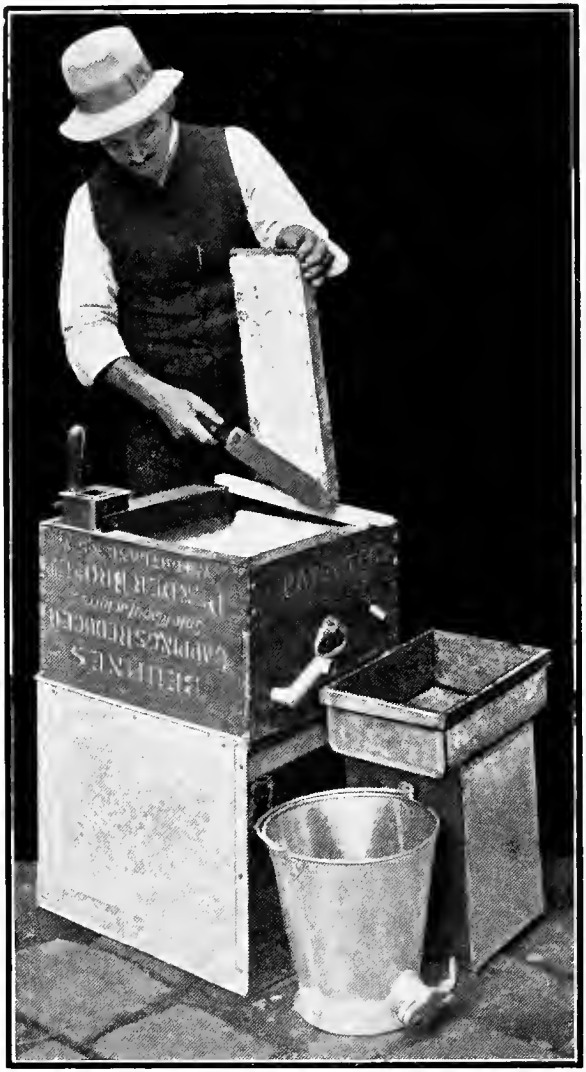


Fig. 2.—Uncapping into Patent Cappings Reducer.

the real one, and a honey gate at one end, will be found more serviceable. It should be large enough to hold the cappings of a day's work, as they drain very slowly; they should be broken up and worked about now and again to hasten draining. In Fig. 3 an uncapping can is shown, the

honey from the cappings drains through a wire screen and is drawn off through a honey gate at the bottom.

Even when allowed to drain for several days, a considerable amount of honey remains in the drained cappings, and although this is recovered

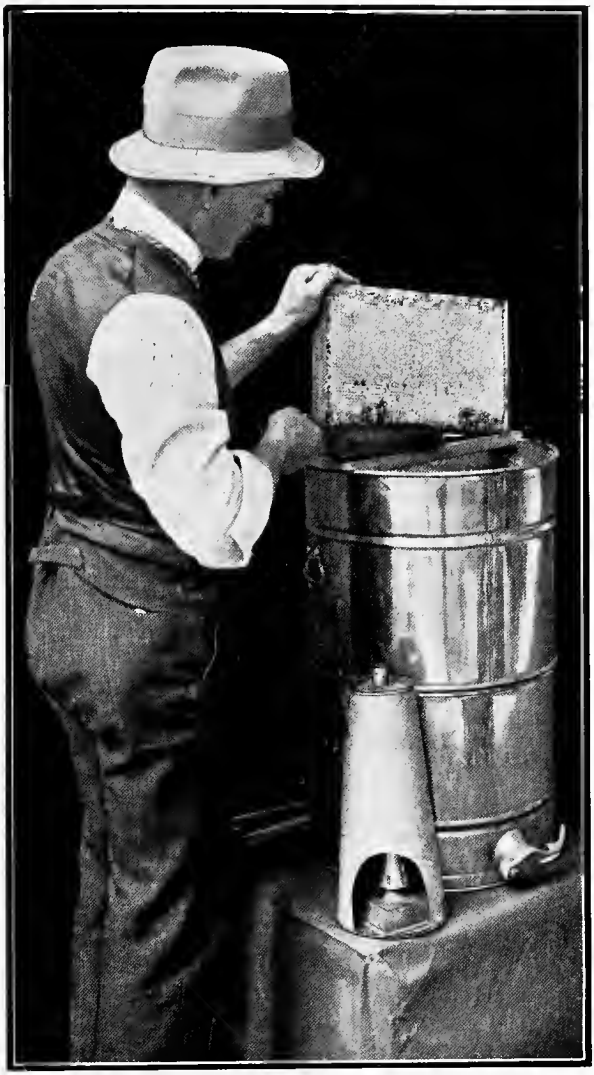


Fig. 3.—Uncapping Can. Wrong way of holding Comb.

when the material is melted down for wax, it is dark in colour and of a waxy flavour. The drained cappings are usually transferred to the solar wax extractor, a tin-lined box covered with a pane of glass facing the direct rays of the sun, and in which the wax melts and liberates the

honey. Cappings are, however, awkward and slow to handle, and as the solar extractor does not work on cloudy or hazy days, accumulations occur during the busy season. By means of cappings melters, all handling of this sticky material is dispensed with, the cappings are melted as fast as they are sliced off, and honey and wax separated.

Several different types of reducers, as cappings melters are called, are on the market. The simplest form is that shown in Fig. 1, and consists of two metal cans, one inside the other, with a space for water between them. It is heated from the bottom by a kerosene stove placed under the stand, a double wire screen prevents unmelted wax escaping by the outlet gate, while the honey knife is kept hot in an opening between the inner and outer can. Honey and wax flow out into the receiving vessel together, and separate owing to their different specific gravity. The wax

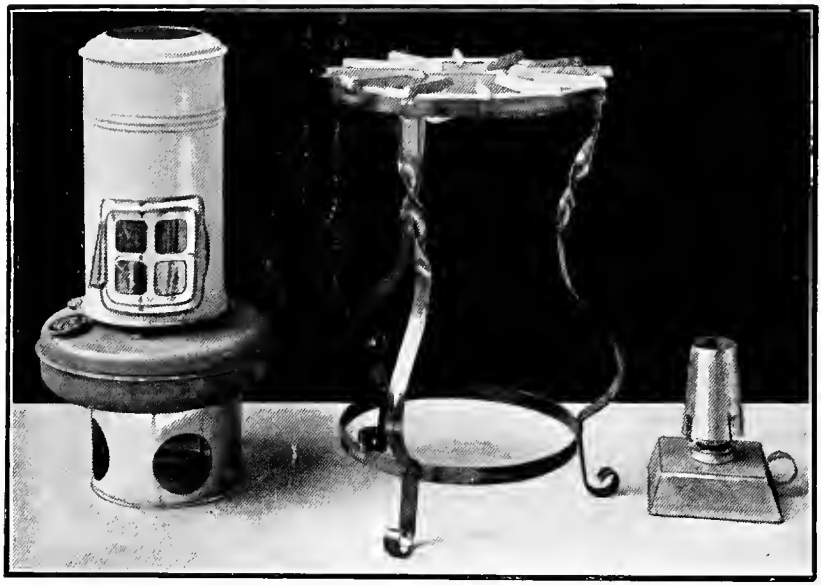


Fig. 4.—New Perfection Oil Stove for Heating Capping Melters.

is allowed to set on top of the honey, and thereby imparts a flavour to the latter. This apparatus is known as the "Simple Cappings Melter."

For apiaries of fifty colonies and over it is best to have the "Patent Cappings Reducer," illustrated in Figure 2. It is composed of an outer and an inner metal casing forming a jacketed space for water between the two. Two opposite sides are connected transversely by square tubes set $\frac{1}{8}$ inch apart forming a grid. This apparatus is made of copper, which is tinned where it comes in contact with honey or wax, while it is encased in wood to conserve heat. It rests on an iron stand, and is heated by a kerosene stove. The cappings, as they leave the honey knife, fall on to the grid of tubes, on which they quickly melt in contact with the hot metal, the resulting liquid passing through between the tubes into the

receiving tray in the lower part of the machine. This receiver is made of stout tin, in the shape of a drawer, with a board front. At its lowest point it connects with an elbow swivel tube on the outside, which is set to the correct elevation to keep the level of the liquids in the tray slightly below the wax outlet tube on the upper part of the receiver. Before commencing work sufficient honey is put into the receiver to cover the end of the honey tube inside the tray. As liquid wax and honey accumulate, and the level of the upper and outside end of the tube is reached, honey will commence to flow from the elbow tube, while the liquid wax, owing to its lesser specific gravity, floats on top of the honey, and gradually rising overflows into a mould placed underneath the wax outlet tube in front of the machine.

The elevation of the honey tube should be such that while a continuous overflow of honey and wax is maintained during uncapping of combs, both liquids should run from the machine free from impurities, the dross, of which there is a considerable quantity when old black combs are uncapped, should remain in the tray. Before uncapping the last super of combs the honey-tube may be slightly raised to force as much wax out of the wax tube as can be got out clean; when all the cappings have disappeared through the grid the honey tube is gradually lowered, and the honey allowed to run till the first indications of impurities appear, when it is turned up. The cake of dross, which still contains a little wax, is removed from the tray when cold, sufficient honey generally remains to cover the end of the honey tube ready for further work. From what has been said, it will be seen that the well-known U tube principle is employed to effect continuous automatic separation of liquids of different specific gravity; the receiver representing one arm of the tube and the elbow tube the other.

A stove is needed to keep the water in the machine at boiling point. A Primus stove may be used, but, while it will work quickly, it will give rather too much heat when used in full blast, and requires occasional pumping up and pricking. The New Perfection Blue Flame Oil Stove, illustrated in Figure 4, will be found the most satisfactory means of heating cappings melters. It takes somewhat longer than the Primus stove to bring water to the boiling point, but the heating power can be adjusted to a nicety, and, if handled according to the instructions supplied with it, requires no attention whatever. Under the Patent Cappings Reducer it is used without the iron stand supplied with it, so that the funnel may project through the circular opening in the top of the Reducer stand. Under this Reducer the stove rests on a support, as shown on the left of the illustration (Figure 4). For other purposes it is used in the stand shown in the centre.

XI.—Treatment of Honey After Extracting.

Clear honey realizes a better price than cloudy or congealed samples; the latter is the trade term applied to candied honey. Producers should, therefore, aim at having their honey remain clear and liquid for as long a time as possible. This can be accomplished by the removal of the factors which hasten granulation, namely, excess of moisture, pollen grains and air bubbles.

The percentage of water in honey depends upon the degree of humidity of the atmosphere at the time the nectar is gathered and converted into honey by the bees, and, to a lesser degree, the flora from which the nectar was obtained. Honey the produce of ground flora such as clovers, dandelion, cape weed, &c., is generally not so dense as honey from eucalypts, and as a rule candies quickly.

When granulation takes place, the crystallizing sugar will sometimes settle to the bottom of the vessel, while the non-crystallizing portion remains on top. This peculiarity of some honeys is often noticed when it is put up in glassware, and has given rise to the erroneous idea that sugar has been added.

In a moist district, or in any locality late in the season, honey should not be extracted until the combs are well sealed over by the bees. Not only does the percentage of water in honey stand in a certain ratio to the humidity of the atmosphere at the time of gathering, but even after being extracted it will give off or absorb water from the atmosphere, acting in this respect much in the same way as salt.

In the combs of the bee-hive, honey is to a large extent protected against the varying influence of atmospheric moisture by the wax cap with which each cell is closed by the bees, when the honey has reached a certain degree of density. The honey producer should adopt the same means of excluding moisture by hermetically closing the vessels containing honey. Further, it should be noted in connexion with the wintering of bees, that the winter stores should consist of sealed honey. Honey gathered late in the season, stored into combs previously extracted, cannot be properly ripened and sealed over by the bees owing to the low temperature and high humidity of the atmosphere, and when consumed by the bees will react detrimentally on their health and vitality. When bees are in a state of nature, little or no honey will be stored so late in the season, all available comb having been filled earlier. The building of new comb is possible only at a comparatively high temperature.

Heating Honey to Prevent Granulation.

During or after extracting all honey should be heated to 160 degrees (Fahr.). At this temperature, honey is as thin as water, readily clears itself of air bubbles, pollen grains, and particles of wax, all of which rise to the surface, while at the same time a certain percentage of water evaporates and some of the crystallizing sugar is inverted, or changed into a non-crystallizing kind.

At ordinary temperature honey is an exceedingly sluggish liquid, and it is impossible to strain it through anything fine enough to remove impurities. With the application of heat, the necessity for straining disappears, all impurities rising to the surface, where they can be skimmed off when the honey is cooled down again. As stated, honey is a sluggish liquid, but it is also a poor conductor of heat: it is very important not to lose sight of these two factors when heating honey, otherwise it may be badly injured in colour and flavour.

When heat is applied to a vessel containing water, circulation at once commences, and the temperature of the whole body rises simultaneously; not so with honey; it is quite possible to burn portion of a

tin of honey while the remainder is still quite cold, or in a candied state. Thus, it will be seen that the methods employed in heating other liquids cannot be used for honey. Heat should never be applied direct. Vessels containing the honey to be heated should be put into another vessel containing water. The heat is applied to the outer vessel either direct, by means of hot water circulation or by steam conducted into the water. The temperature of the water surrounding the tins should never exceed 170 degrees Fahr., unless the honey is kept in motion by continuous stirring.

If honey is heated at time of extracting it will not only be much clearer and brighter, but the candying will be, to a great extent, prevented, or considerably delayed. Moreover, honey so heated, if eventually it does candy, while still in the hands of the producer, will not throw up a layer of scum when being reliquified, as is the case with honey not previously heated.

It is, therefore, desirable that all honey should be heated before being packed for market; but as at extracting no time is available to heat honey in the laborious way of immersing tins in hot water before emptying them into the settling tank, an apparatus which will automatically heat the honey on its way from the extractor to the honey tank, is a great labour-saving device in the production of honey on a large scale. This apparatus, known as the honey-heater, consists of an inclined plane, divided off into a number of narrow races, down which the honey from the gate of the extractor passes in a thin stream over a hot metal surface. Quick heating to the required temperature is obtained by the spreading out of the stream of honey over a comparatively large surface. The apparatus is constructed of tinned copper and filled with water, which is heated by means of a blue flame stove placed underneath. The correct temperature of the heated honey is ascertained by means of a thermometer, over the bulb of which the honey runs before entering the tank, and regulated by the raising or lowering of the flame of the stove.

Liquifying Candied Honey.

When honey has candied solidly, it cannot be liquified hurriedly; from eight to ten hours will be required at a temperature of 165 degrees in a hot water bath for honey set hard in 60-lb. tins.

To compensate for the slowness of this process, the heating of the water bath should be so arranged that the correct temperature is maintained automatically. This is best accomplished by using the blue flame stove illustrated in the previous chapter. When large quantities of candied honey have to be liquified, provision should be made for heating a number of tins simultaneously in a bath holding from twelve to sixteen 60-lb. tins. If such a bath is constructed specially for the purpose, the dimensions should be such that there is a space of ½ to 1 inch between the tins. These should rest on strips of wood at least ½ inch thick, so as to prevent contact between the bottom of the tins and the bottom of the bath, and to allow the water to circulate all round the tins. The bottom half of a square 400-gallon water tank which has been cut in two horizontally is used by some bee-keepers for heating honey. Battens are laid across the bottom for the honey tins

to rest upon. The tank is placed over a small excavation, or on a few bricks, so that a small fire can be lighted under it. It is filled with water to near the top of the honey tins, of which it holds sixteen.

When a specially made bath is used, it is best to use hot water circulation instead of a fire underneath. The bath may consist of a stout wooden case of the desired dimensions, lined with galvanized iron and connected by means of two pipes with a boiler made of an oil drum or a copper closed with a dome. The boiler or copper is set in the fireplace, while the bath may be some little distance away on the floor of the honey room, and thus the heating of the honey may be done indoors at any time, and with a minimum of shifting about of the heavy honey tins.

In liquifying candied honey, it should be remembered that every particle must be dissolved, otherwise granulation will soon recommence, the remaining undissolved crystals, however small, acting as nuclei for fresh crystallization.

XII.—Comb-honey.

In Victoria, and in Australia generally, the amount of honey marketed in the comb is only a small fraction of the total production. In England, the United States, and Canada, a considerable portion, perhaps nearly one-half, of the honey used for table purposes is in the comb.

In North America, the production of comb-honey in 1 lb. sections has attained to large dimensions, and many large apiaries are run exclusively for the raising of high grade section-honey, high prices being obtainable for what is graded as "fancy." In the profitable production of comb-honey, considerable skill, and favorable conditions of climate and flora, are essential.

That a larger amount of honey in the comb is not consumed in Australia is often attributed to lack of enterprise of the apiarists, or to the absence of consumers willing to pay the extra price for honey in the comb, as compared with extracted.

Well filled sections of comb-honey with perfectly clean white cappings can only be obtained in localities which have a heavy honey flow lasting sufficiently long to insure uninterrupted work in the sections from start to finish. The profitable production of comb-honey is only possible under a combination of favorable conditions not present in every locality, and not every season. Comb-honey may, as a matter of fact, be produced whenever bees store more than is needed for their own immediate requirements, but very few bee-keepers are aware at what cost, through loss in yield, this is done when attempted under unfavorable conditions. There are seasons when bees will produce a fair amount of honey when given ready-built combs for extracted honey, but if compelled to work in sections, a very small yield of inferior comb-honey will result.

The true causes of the small production are, however, the climatic conditions of our country and the vagaries of blossoming and nectar secretion of our native flora. The yields of honey are equal to those obtained in any part of the world, when taken on an average for

several years, but our high average is made up of a glut one season and a comparative dearth in the following. We have " on " and " off " years; and, while it is comparatively easy to produce good sections in the " on " year, it would be quite unprofitable to attempt it in the " off " year.

In the case of extracted honey, much of it is held over from one season to another without any deterioration in quality. Comb-honey, however, cannot be kept in perfect condition for any length of time, except with a considerable amount of trouble in providing dry warm storage. Thus, 1 lb. sections may be rather plentiful one season and almost unobtainable the following, and the prices proportionately high. Under these conditions, neither production nor consumption can be expected to increase.

Some ten to fifteen years ago, several apiarists produced comb-honey on a large scale, but abandoned its production for that of extracted honey. Much of the section honey which finds its way on to the market now is produced by bee-keepers in a small way; and in appearance leaves much room for improvement.

As already stated, skill is required to produce comb-honey profitably. The conditions necessary to make comb-honey production profitable are—1. A sufficient amount of the right kind of honey-producing flora within reach of the bees. 2. Atmospheric conditions favorable to the secretion of nectar and the flight of bees. 3. Strong colonies in which the maximum number of the workers are field bees. The factors 1 and 2 depend upon the locality, while the third is one depending upon the skill and energy of the bee-keeper; this should from the very commencement of the season be directed towards securing the greatest possible number of field bees in each hive at the beginning of the main honey flow, and to maintain the strength of the colonies while the honey flow lasts. Under Australian conditions, such as the irregular blooming of some of the honey-producing trees and the periodical scarcity of pollen, it is in some localities practically impossible to bring colonies to that condition which is necessary to the profitable production of first-class 1 lb. sections of comb-honey. In districts where the main honey flow begins shortly after the blooming of that valuable pollen plant, Cape Weed, there is little difficulty in having colonies in the right condition for comb-honey, provided that they had wintered well, and that each colony has a vigorous queen. Cape Weed is now so widely distributed over Victoria that there are few localities where it is not plentiful on any open spaces, for it does not thrive in close forest or scrub country, and is, therefore, absent in the vicinity of some of the best apiary sites in the State. In such localities the hives are often not in a condition to produce comb-honey at a profit, and the colonies had better be kept in a locality with a plentiful early pollen supply and shifted on to the honey site when the flow begins.

There are many other localities where Cape Weed and other pollen producers are plentiful, but too long an interval occurs before the honey flow commences, and the bees are then often in a backward condition, more so when, as is usually the case in such districts, there has been much swarming. Swarming is a factor that has to be reckoned

with in the production of comb-honey. It is a well known fact that when extracted honey is produced there is much less swarming and no difficulty in keeping the colonies strong, particularly when the queen is given free access to the upper story or stories up to the time of the first extracting, or where the honey flow is very heavy throughout the season. When sections are placed on the hives, instead of extracting combs, the bees will be much slower going up into the super, and will become so crowded in the brood chamber that swarming results. Thus the worker-force is divided, neither the swarm nor the parent colony is in a condition to store surplus honey for two to four weeks, or longer, if the stock was only of medium strength before it swarmed.

Often before either of the two colonies is ready for storing in sections the best of the honey flow is over, and what usually occurs, particularly in the districts near Melbourne, is that the number of colonies is doubled, a few highly coloured and stained sections are produced, a number of swarms abscond, and some of the later casts die of starvation before spring.

To deal successfully with the swarming problem in connexion with comb-honey it should, first of all, be understood that destroying the queen cells which are raised by a colony preparing to swarm does not prevent swarming, it only delays it, except when conditions unfavorable to the bees, such as bad weather or a stoppage of the honey flow follow immediately after the destruction of the queen cells.

Although the production of comb-honey in 1-lb. sections encourages the swarming impulse, yet there will usually be found in an apiary of any size a few colonies which, while equal to the best in population and yield of honey, go through one or two entire seasons without swarming. Such stocks give a maximum return for a minimum of labour and attention, and their number should be increased by rearing the young queens required from the queens of these non-swarmers.

To obtain the best results, the manipulation of the colonies should come under two different headings: 1. Preventive measures. 2. Control of the swarming impulse.

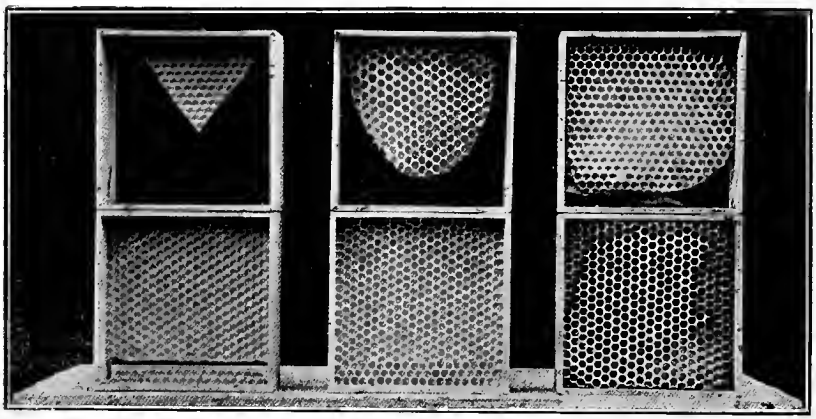
1. Preventive measures should commence long before there are indications of swarming. The brood chamber should never be allowed to become too crowded with bees, nor should it have any great quantity of honey in combs not occupied by brood; further, the less honey there is between the brood and the top bars of the frames, the sooner will the bees work in sections when the latter are put on. There are different ways of getting a colony into the right condition for work in sections, such as uncapping combs of sealed honey and inserting them, one at a time, between the brood at intervals of four or five days, or doing the same with extracted combs if honey is plentiful in the hive or coming in freely. Operations such as these, however, require an amount of time and labour which few Australian bee-keepers are prepared to give, neither is the artificial stimulation thus produced always an advantage. We cannot predict to a week or so when a particular honey flow will start, and it is therefore better to let the development of the colonies proceed on natural lines. The simplest way of getting a colony in the right condition will be found to be to allow an expansion of the brood nest upwards into a set of drawn combs, and then at

the right time for putting the sections on, to put the combs containing the most brood, especially the sealed, into the lower body, shaking the bees off the surplus combs in with the others and using the combs to help on weaker stocks. When a two-story colony has thus been reduced to one set of brood combs and one or two section supers, the bees are forced to enter the sections at once. A few bait sections, that is, unfinished previous season's sections, put amongst the empty ones will be a great inducement for the bees to commence work at once. During hot weather the preventive measures should include enlarging the hive entrances and shading the hives during the hottest part of the day.

2. Controlling the swarming impulse. Even after everything possible has been done in the way of prevention, there will still be swarms, few or many, according to the strain or race of bees kept and the character of the locality. The swarming impulse may be controlled in two ways—by anticipating it, or by allowing natural swarming to take place and reuniting some time after. The principle which underlies all methods for the control of the swarming impulse is an interruption in the hatching of young bees; this is what takes place in natural swarming. From the time a swarm commences work in the new hive at least 21 days elapse before young bees again emerge, by this time the swarm will have lost many of its former numbers, and is therefore not in a condition to give the best results. When swarming is anticipated, this interruption in the generations of hatching bees is brought about by the removal of the combs containing brood and the substitution of empty drawn combs or frames of foundation. This is usually done when a colony starts raising queen cells. If the colony, although preparing to swarm, is then not yet strong enough, the cell cups may be destroyed and the brood removed a week or a fortnight later. Under certain conditions of season, colonies deprived of all brood may be inclined to swarm out. This may be prevented by taking away half the brood combs, and when, five or six days later, young brood is found in the combs which were substituted for the brood, the remaining combs of adult brood may then be removed. The brood thus removed in anticipating swarming, may be given to backward colonies after shaking most of the bees off. Before any combs are taken from a hive, the whereabouts of the queen should be ascertained lest she may be injured in the shaking of the bees. Too many combs of brood should not be given to any very weak stocks, or much of it will be wasted on account of the inability of a small colony to take care of it.

This above method of swarm control involves a considerable amount of work and attention, and most bee-keepers find it more convenient to allow natural swarming to take place and, after a time, to reunite the swarm and the parent stock, thus getting the same force to work in one hive as if the colony had not swarmed at all. When the swarm issues it is hived on the same stand, while the parent stock is placed alongside, but with the entrance facing at right angles from the old position. Nearly all the flying bees which remained when the swarm came out will return to the accustomed place, and thus join the swarm, weakening the parent stock sufficiently to prevent after-swarms. If the bees are of a desirable strain, one of the queen cells in the swarmed stock

may be allowed to hatch. This should be the most perfect and forward one, the others are destroyed. If the colony is not one of the best, cells raised from one of the best non-swarming stocks may be given. In from fourteen to twenty days, according to the maturity of the cell on day of swarming, the young queen should be laying. Twenty-one days after swarming all the worker brood will have hatched out, and the bees may be united with the swarm after removing the queen of the latter (the old queen) and the combs of the parent stock, if section honey is to be raised. (The method of uniting is described under Swarming, Chapter IX.) The colony is now in the best condition, with a young queen and new combs in the brood chamber. These are very desirable when clean, white sections are to be raised. From a colony manipulated in this way the writer, some years ago, obtained 312 beautifully finished 1-lb. sections in what is by no means a first-class locality.



1-lb. Sections of Comb-Honey.

Upper tier from starters, lower tier, full sheets.

Much of the faulty appearance of sections seen in shop windows, as well as most of the damage comb-honey suffers in transit on the railways is due to false economy on the part of the producer, who provides the section boxes with only a small starter of foundation, as shown in the first section of the top row in the illustration. This section stands on one supplied with a full sheet of the thinnest foundation (12 to 13 square feet to the lb.) and a bottom starter.

The progress of the work of the bees may be seen in the second and third pair of boxes. The third one of the top row, although almost ready for sealing by the bees, is not fastened to the bottom of the section; while, in the lower tier, the comb is already fastened to the wood all round in No. 2 and completely fills the box in No. 3.

Apart from the quality of the produce, which would be the same in either case, there are two things to be considered in section honey, viz., appearance and weight. A section built from a starter will be partly sealed before comb-building is finished, and the cappings will often lose

their virgin whiteness before the sections are ready for removal from the hive. Drone comb is also usually resorted to by the bees; and the finished section has not an even surface, nor is it fastened to the wood all round, and whatever spaces are left open increase the liability to break down in transit and to deduct from the weight.

When a section is built from a full sheet of the thinnest foundation and bottom starter the bees first of all join sheet and starter, as in No. 2 of the bottom tier. They then raise the comb simultaneously over the whole face and seal or cap it all over at one time, so that, when ready for removal, the capping is snow-white, the section full weight (15 to 16 oz.), and being a solid block of comb completely filling the box will not break down and leak in transit.

It is, however, important that only thin surplus foundation should be used, as stout foundation is objectionable when eating the comb. It should not be less than 12 square feet to the 1 lb. This grade costs 2s. 8d. per 1 lb., which will cut 100 full sheets and bottom starters, or 400 top starters as shown in first section of the top tier. The cost per dozen for foundation would thus be 4d. for full sheets and 1d. for top starters; but as well-filled snow-white sections, such as can only be obtained from full sheets, are worth from 1s. to 2s. per dozen more, there is an actual gain of 1s. to 1s. 9d. per dozen in using full sheets and bottom starters.

There is yet another advantage in the use of full sheets; that is, brood and pollen are not so likely to find their way into the section boxes. When the brood-chamber consists, as it should do, of worker-comb, bees will often build drone comb and raise drones in the section boxes, when given the opportunity afforded by the use of small starters.

What has been said here should not be understood to mean that first-class sections cannot be obtained from small starters. Under the favorable conditions of a good honey flow and strength of colonies, first-class sections, fastened to the wood all round, may be produced without the use of full sheets and bottom starters in the sections, but what is saved in labour and cost of extra foundation is lost many times over in the smaller number of sections.

Pollen.

Pollen is the male element or fertilizing dust of the flowers of plants. It consists of minute grains mostly less than 1-1,000 inch in diameter, of varied, often beautiful, forms; in colour, innumerable shades of yellow, orange, cream, red, purple, brown, blue, and green—the last-named two being somewhat rare. Each pollen grain consists of an outer comparatively hard, and an inner elastic shell enclosing a jelly-like nucleus of protoplasm.

Before the production of fertile seeds can take place, it is necessary for the pollen grains, which are produced in the anther of the male organ, to be transferred to the female organ of the flower. In most plants, male and female organs occur in the same flower; in many others, in separate flowers on the same plant; while in still others, male and female blossoms are each produced on separate plants. As plants are

incapable of voluntary motion, nature employs various agents, such as wind, water, birds, and insects, to convey the pollen from the male to the female organ. The pollen grains of the flowers of different plants vary considerably in shape and character, and in numbers. Thus, while wind-fertilized plants, such as pines and grasses, produce enormous numbers of pollen grains, which have little or no means of cohesion, are carried away and scattered by air currents like dust, the pollen grains of insect-fertilized flowers are sticky, as in the case of Eucalypts, connected with each other by viscid threads, as in some plants of the heath family; or are covered with spines, as in many composite flowers—Cape Weed, Dandelion, &c. By these means, the pollen grains become attached to insects visiting the flowers, and are thus conveyed from the anther to the pistil of the same flower, or of another flower of the same species on a different plant, thus effecting fertilization and cross-pollination.

In the fertilization of most cultivated economic plants, the honey bee is the most important of the insect agents, on account of its habits, its structure, and its continuous need of nitrogen. Pollen is the only source of nitrogen available to the bee; without pollen, no reproduction can take place, not a single bee larva can be reared without pollen, or a substitute of it. The nitrogen of pollen is, in the form of protein, present in quantities of 17 to 27 per cent.

In the economy of the bee hive, pollen is equal in importance with nectar; for while honey is a complete food for the adult bee during inactivity, nitrogenous food is required, not only for the rearing of young bees, but for the conversion of the nectar into honey. The larval food and the enzyme, which causes the inversion of the sugars of nectar, are both animal secretions of the bee, with nitrogen as their base.

Owing to the climatic conditions of many parts of Australia, pollen famines occur periodically with detrimental and sometimes serious results to the bee-keeping industry. Unfortunately, no substitute for pollen, satisfactory under our peculiar climatic conditions, is so far known. Some measure of success has been obtained by the feeding of powdered skim milk, but it amounts to little more than saving the colonies from extinction, or tiding them over a short period of dearth, much in the way that farm animals are kept alive by the feeding of straw.

When the detrimental influence of pollen famines is more fully realized by honey-producers, steps will perhaps be taken to inaugurate systematic, scientific researches and experiments to investigate the inter-relation between abnormal bee mortality and dearth of pollen, and to find suitable substitutes for pollen.

The natural honey resources of Australia are so good, and the normal climatic conditions so favorable to bee culture, that the solution of the problems due to abnormal periodical climatic conditions would, from a national point of view, be highly reproductive.

XIII.—The Rearing of Queen Bees.

The selection of a queen from which to breed for the purpose of superseding old or inferior queens, or the queens of colonies showing a predisposition to disease, viciousness or some other undesirable trait, is not only of the greatest importance but also a most difficult problem.

It is upon the prolificness of the queen and the longevity and vigour of her worker progeny that the larger or smaller amount of surplus honey depends; but the most prolific queen is not necessarily the best to breed from. Experience has shown that the queen progeny of an exceedingly prolific queen rarely equal their mother; when they do, they produce workers which are constitutionally delicate, and these never yield the amount of surplus which one should expect from the great number of bees raised. A prolific queen producing vigorous long-lived workers is very soon restricted in egg production by the relatively large number of old field bees, the honey gatherers filling much of the comb with honey once the colony has attained normal strength. In the case of a colony having a queen producing short-lived workers the position is reversed. Many of the bees in such a colony die soon after reaching field bee age; therefore the young, the nurse bees, predominate. It is the work of the young bees to feed larvæ, prepare cells for egg-laying, and attend the queen. As the number of field bees bringing in honey is little more than sufficient to supply what is needed for immediate consumption, the colony will show a very large amount of brood in all stages right through the season but will store less honey for the apiarist than colonies which, with a smaller amount of brood, have far more old field bees.

As a breeder, I prefer the queen of a colony which has the maximum number of bees from a moderate amount of brood during a season. This results naturally in a good yield of honey, and indicates longevity of the bees. There are, however, other desirable characteristics, such as purity of race, gentleness, and absence of excessive swarming, which are needed. The number of queens which conform to all these requirements is, even in a large apiary, usually rather limited.

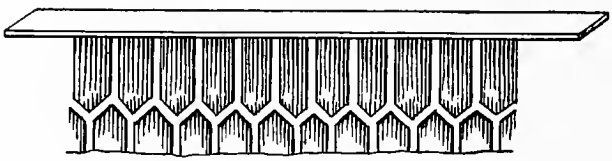
Important as the selection of the queen mother is, the raising of the young queens by the best possible method, and under the most favourable conditions, is not less so. Poor queens may result when queens are raised under unfavourable conditions, no matter how suitable the mother queen is. There are many different methods of raising queens and good queens may be obtained by any one of them if everything is just right. The difficulty is, that many bee-keepers fail to observe when conditions are suitable and when not. A prosperous condition of colonies, an income of pollen and honey, and a warm moist atmosphere, are essential. A heavy honey flow is not the best time for queen rearing, particularly when it occurs during hot dry weather. There may be both pollen and honey coming in, and yet the right conditions may not exist, even though atmospheric conditions appear favourable. This is probably owing to some deficiency in quality of the stores gathered. It may, however, be taken as an indication that conditions are favourable when the young larvæ are surrounded by a plentiful supply of pure white food. The colony selected for raising cells from the eggs or larvæ of the chosen breeding queen should be strong, particularly in nurse bees.

The "Doolittle" method of transferring young larvæ to artificial cell cups and getting the cells raised, either in a queenless colony or over the queen-excluding honeyboard in the super of a strong colony, has the advantage of enabling one to know exactly when the queen cells will hatch. The same advantage can be obtained by the "Alley" method without disturbing the young larvæ. Queenless bees are compelled to raise queen cells under the impulse of self-preservation, whether the conditions are suitable or not. Often they appear to raise them rather hurriedly. There

is no doubt that good queen cells are produced by bees bent on swarming (in the proper season). They are raised deliberately, and only when conditions as to food supply and strength in bees are suitable. But the bees of queens from swarm-cells inherit the swarming impulse, which the best apiarists of all countries are trying to eliminate, and such queens are therefore not desirable in any numbers.

There is yet another impulse under which bees will raise good cells; the superseding impulse. When a queen is in her third season, and long before the apiarist can notice any decline in her prolificness, the bees usually prepare to supersede her by raising one or more queen-cells. They do this at a time when the conditions are most favourable; they are usually better judges of this than their owner, excepting in the case of a queen suddenly failing from disease or accident. If the bees are inclined to swarm there may be a swarm issuing before or after the cell or first cell hatches Where the bees are less inclined, the virgin queen on emerging from her cell will destroy all other cells but will take no notice of the remaining old queen, her mother.

The number of cells raised under the superseding impulse is not large —from one to three usually; but they are invariably fine large cells producing splendid queens. For a number of years I have obtained some of my best queens in this way, but as the number is limited I could not get sufficient, till I made use of the superseding impulse for raising them

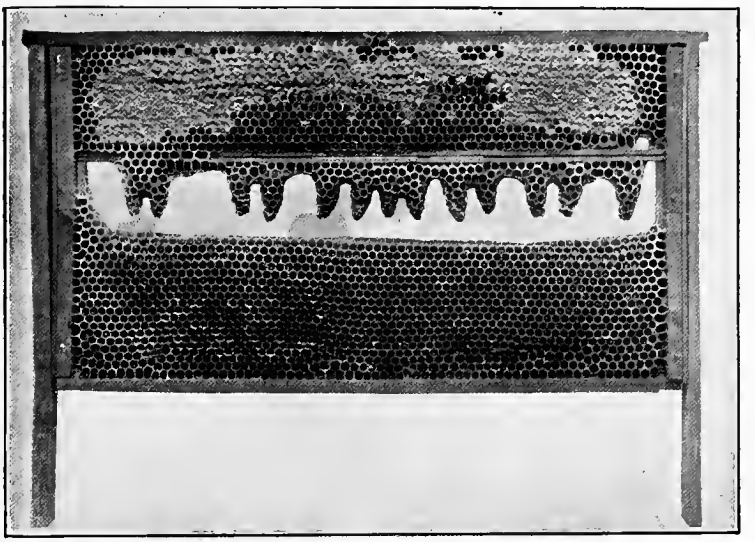


1. Comb Cut for Queen Raising.

from larvæ supplied repeatedly to the superseding colonies from selected breeding queens. For this purpose it is necessary to know the ages of all queens. Colonies having queens in their third year are examined periodically when conditions are favourable. If there are indications of superseding, the cells are removed and larvæ from the breeding queen, over which cell cups have previously been started by temporarily queenless bees, are given in place of those removed. The colony should naturally be populous and thriving enough to raise good cells. If the queens which are not up to standard are replaced every year irrespective of age, these three-year-olds are those which passed all the musters and there will be no lack of the necessary condition. Should none of the superseding colonies be of sufficient strength other strong ones may be made by exchanging queens between colonies with old queens and strong colonies with younger ones.

To have all the queen-cells mature at the same time, so as to be able to leave them where they are raised till the day before they hatch, it is necessary for the young larvæ from which the queens are to be raised to be all of the same age. This is not a difficult matter for any one knowing from experience the size of the grubs at different ages. At eighteen hours old, they are of about the size of the small c of ordinary type and will hatch on the twelfth day. For the purpose of obtaining larvæ of the right age in sufficient numbers. I do not find it necessary to insert an

empty comb into the brood chamber of the colony with the selected queen, because, at a time suitable for queen rearing, sufficient larvæ for the purpose should be in every hive. To obtain the larvæ I cut a piece, four to six inches long and the width of three rows of cells, out of a comb in a suitable place. By cutting it again through the middle row of cells two single rows are obtained. These are fastened with liquid wax cell end on, to a thin strip of wood. The open row of cells is then cut down to half the depth (Fig. 1) by means of twirling a wooden match head first into the surplus larvæ. Those of the wrong age and any eggs which may be present are removed, leaving as far as possible one larva of the right age in every third cell. These strips of comb are then fixed in gaps cut into a comb and given to queenless bees for 6 to 12 hours to mould queen-cups round the larvæ. They are then fitted into an outside brood comb of the superseding colonies.



2. Queen Cells Grouped in Comb.

When the cells are sealed the strips may be removed and grouped into a comb, as shown in Fig. 2. This is placed into the super of a strong colony over a queen excluder where they may remain till distributed in cell protectors to nuclei about the tenth or eleventh day after they are started. Started queen-cells may again be given to the colonies which raised the cells as soon as the sealed cells are removed but the brood combs should be examined occasionally for a cell they may be raising on their own account. Three to six cells are all I raise in a superseding colony at a time. When greater numbers are raised they are not so perfect. The thirteen cells in Fig. 2 are on three strips, each from a different superseding colony.

The great advantage of this method of queen-rearing is that, having a laying queen in the hive, the bees will not raise the cells given, unless conditions are as they should be. No inferior queens will therefore result.

XIV.—Nuclei.

The word nucleus in bee culture means a small colony of bees taken from a normal colony and established separately in a small hive. The number of bees in a nucleus may vary from 500 to several thousands, the strength of population being regulated by the beekeeper according to the season or the purposes for which nuclei are formed. There are two distinct objects in making nuclei by the division of a stock of bees or of a swarm, one being increase, the other the mating of virgin queens. If the object is increase in the number of colonies, each nucleus should consist of not less than one-fourth of a normal colony, otherwise the end of the season will have arrived before these small colonies have developed suffieiently to winter safely.

For the mating of queens, nuclei are indispensable to the queen-breeder and the modern apiarist, but for this purpose the number of bees in each little hive may be much less, the object being merely to

Nuclei Hives for Mating Queens.

provide a separate habitation for each young queen, with a minimum of worker bees, consistent with taking care of their abode and resisting climatic influences.

In the raising of queens for the purpose of superseding those which are either too old, or otherwise inferior, bee-keepers often encounter difficulties in any one of a number of methods employed to get the young queens safely laying.

The most direct, but also the crudest and most wasteful way, is to kill the old queen and either let the bees raise cells themselves or supply them with a queen-cell previously raised elsewhere. If the queen killed were old, but had been a good one in her time, the bees may raise a good young queen from her brood, but in the case of an inferior queen no improvement, except in age, need be expected. When a queen-cell of good stock raised under the proper conditions is

given, the result will be as good as by any other method, so far as the vitality and prolificness of the young queen are concerned.

In either case, however, there is a considerable loss in the reproduction of the worker-force of the hive, much less certainly, but still considerable, when a cell, ready to hatch within two days, is given. When allowing the bees to raise a new queen themselves after destroying or removing the former queen, it will be at least 21 days before the young queen commences egg-laying; when a cell is given, it will be twelve days during which reproduction is at a standstill. Now, as good queens cannot be raised, excepting under the very conditions which cause brood-rearing to be at its best, it follows that breeding is interrupted just when it should be at the maximum. Even a poor or old queen will at such a time lay 500 eggs per day, representing for 21 days a worker force of 10,500 bees and 6,000 for twelve days, but as young bees continue to hatch for 21 days after the old queen is removed, the weakening of the colony does not become evident till a month afterwards, by which time the circumstances have probably passed from memory.

It is a generally understood fact that there can be only one queen in a hive at a time and, with the one exception referred to further on, that holds good, as, on the average, from the time the young queen hatches till she begins to lay, ten days elapse, and a break in egg-laying for that period must of necessity occur. To reduce this interruption of breeding to a minimum, or to do away with it altogether, different methods have been evolved and practised, principally by American bee-keepers in the first instance.

The plan which does away with stoppage of egg-laying altogether is to confine the queen to the combs of the lower chamber by means of a queen-excluding honeyboard. About half of the combs of brood are placed in the upper story, to which a separate entrance is provided. A queen-cell is given above and the young queen will take her mating flight from the upper entrance, and in due course will commence to lay while the old queen in the lower chamber still continues. The young laying queen may be removed and used elsewhere and another cell given.

This is an ideal method in theory, but success depends upon a combination of circumstances. These are: a colony covering the combs of two stories; a queen in the lower chamber at least two, but better three years old; and a free use of the upper entrance by the worker bees, otherwise the virgin queen when returning from her mating flight, finding no bees at the upper entrance, will be attracted by the lower one, will enter, and either kill the laying queen or be herself destroyed by the bees.

To reduce the total interruption of breeding to a minimum for the number of queens required, the usual practice is to divide one colony into a number of nuclei of two or three combs, each being given a queen-cell and placed apart from others. Many of the bees will, however, return to the former stand, leaving but young bees behind. These are unable to properly take care of the brood and the queen-cell and to defend the little hive against intruders.

There are several ways of overcoming this difficulty. The bees for each nucleus may be taken from any hive which can spare them; they are shaken into a small empty hive, such as the one shown on the right of the illustration. A wire screen is fastened over the top of the box, and it is placed in a dark, cool, well-aired position. On the evening of the day following, that is, about thirty hours later, the box is taken to the spot where it is to be located. A comb of brood and one or two combs containing honey and pollen are taken (without bees) from some strong colony and given to the nucleus, a ripe queen-cell in a cell protector, or a virgin queen, in an introducing cage, being inserted at the same time.

Another way of making nuclei is to break up into lots of two or three combs each, a colony which has just thrown a swarm. As a number of bees will return to the old stand, only one comb of brood should be left in each nucleus. Select for the purpose those combs containing the greatest amount of sealed brood, and place the combs of young brood in the hive on the old stand, where it will be cared for by returned bees.

A swarm may also be divided into nuclei. It is best to allow it to cluster somewhere; then hive it in an empty box and about sunset divide it amongst a number of nuclei hives, each containing a comb of the brood from which the swarm issued and one or two combs without brood. As bees which have swarmed and clustered will stay in any new stand, a greater number of nuclei can be made out of a swarm than a swarmed stock. The queen of the swarm should, however, be removed, otherwise the bees are likely to crowd to the particular box she is in.

By any one of these methods from four to ten nuclei may be made out of a single stock, and thus brood-rearing is interrupted only to the extent of one queen for four to ten new queens. In order to still further economize, American bee-keepers some years ago adopted a system of very small nuclei with miniature frames and only a teacupful of bees in each. These are known as Swarthmore nuclei. Owing, however, to the liability of such very small hives being robbed out when near an apiary, and the erratic behaviour of these small communities in frequently swarming out, the few Australian bee-keepers who experimented with this system have abandoned it. For the raising of the best type of queen, it is essential that from the first start of the queen-cell to the commencement of laying of the young queen, the most favorable conditions should exist. In the case of very small nuclei these conditions are absent during part of the chrysalis and the adult stage of the queen's life. Even in nuclei on standard combs in thin walled boxes holding two or three frames, the period betwen the hatching and laying of the queen is often unduly extended by climatic influences and the vigour of the young queen impaired.

The influence of extremes of heat and cold may be reduced to a minimum by having three or four nuclei in an ordinary hive body, as shown by the uncovered hive in the centre of the photograph. A ten-frame body will hold four, an eight-frame three nuclei of two combs each. The compartments are made by thin, tightly-fitting division

boards, extending upwards to the level of the top of the hive. Each has a separate entrance facing in a different direction and a separate thin cover board independent of the ordinary hive roof.

As it is always desirable to have some spare queens at the end of winter, to make good any losses of queens, these nuclei grouped together in one hive may be carried through the winter, provided there are enough bees in each to nearly cover the combs. When queens have been removed, the divisions may be withdrawn and the bees united under one queen.

Nuclei may be grouped in yet another way by standing, close together, two boxes of two compartments each, as shown in the second hive from the right in the illustration. The advantage of this method is that, after one queen is removed from each box and the bees united, a four-frame super may be put on each, allowing an extension of the brood nest upwards, as shown on the left. When all combs are occupied, an ordinary hive with entrance in the same position may be substituted for the four-frame boxes, the hives moved apart by degrees, and run as independent colonies.

For convenience the nuclei are numbered, the numbers being painted on tablets secured by a nail in the centre and used to indicate the state of each. The number is in normal position for queen laying; upside down, for queenless; diagonal upwards, for queen-cell; horizontal, for virgin; and for queen-fertilized but not laying yet, diagonal downwards.

XV.—Introducing Queens.

The beginner in bee-keeping often has difficulty and sometimes absolute failure in introducing a new queen to a colony of bees. Many of the queens obtained annually from queen breeders are lost in introduction, even by bee-keepers of some experience. The mood or temper of bees and their behaviour towards man and towards their own species are governed by climatic influences, variations in the secretion of nectar, and the methods of manipulation of modern bee-keeping. Incidentally it may here be pointed out that viciousness is a characteristic of some strains, and even of individual colonies of bees, and that such bees will sting when handled even under the best condition; there is, however, no additional difficulty in their inherent wickedness so far as the acceptance of a queen is concerned.

When colonies are in normal condition, the printed instructions usually sent out with queen bees will insure safe introduction; under certain conditions, which will be referred to further on, the usual method must, however, be entirely departed from. To introduce a new queen to a colony it is, first of all, necessary to find and remove the queen which is to be replaced. It is during this operation that, in most instances, the foundation for future trouble is laid. When the queen to be removed is a black or brown one, it often takes considerable time to find her. Bees from other hives are attracted, and the bees of the colony operated on are roused to a state of attacking any stranger; and, when the new queen appears amongst them a day

or two later she may be killed right away or balled and worried to death.

Trouble is sometimes created by returning to the hives newly-extracted combs at a time when, unperceived by the bee-keeper, the honey flow has ceased, and a commotion is caused which is communicated to all the colonies; bees may be seen at the joints between the hive bodies or wherever the odour of honey escapes; when a hive is opened they hover round or boldly dive in between the combs. Under these conditions bees sometimes ball their own queens, and are very unlikely to accept a strange queen when deprived of their own.

The hunting up of queens should be done towards evening, when bees have ceased to fly; care should be also taken that no honey is spilt from combs so as to attract robber bees or ants next day. Bees will most readily accept a new queen after being queenless for from 24 to 48 hours. If queenless longer, queen-cells will have been started and the bees will be less friendly disposed towards a new queen.

In such a case it is better to wait a few more days, when all worker brood will be capped, and, having no means of raising a queen of their own, the bees will usually readily accept a new queen—provided *all* queen cells are destroyed before she is introduced. With a populous colony it is difficult to find all the cells, some of which may be quite small and on the face of the comb. To make sure that none are left it is best to shake the bees off the brood combs, one at a time, and carefully examine the comb all over.

If a queen is to be introduced to a colony, assumed to be queenless because no eggs are present in the combs, a test-comb containing young larvæ from another colony should first be given to see whether the colony is really queenless, in which case queen-cells will be started by the bees within 48 hours. The comb may then be removed and returned to the hive it came from, and the queen introduced. If no cells are started on the test-comb, then a virgin queen is present in the hive and must be removed, as well as the test-comb, before the new queen can be given with safety.

When a queen is received by post, remove the cover of the cage and note her condition. If satisfactory remove the cork or covering slip from the end of the cage containing the candy and, if there is a queenless colony ready for introducing, place the cage wire downwards on top of the broad-frames. The bees, by gnawing out the candy, will release the queen in from two to five days. If, on examining the cage on receipt from the Post Office, the queen is found dead, notify the sender, and as proof return the cage with bees and dead queen—you will then receive another queen—all reputable queen-breeders guarantee safe arrival.

By the method of introduction described above, the worker bees which accompanied the queen are introduced along with her. If the candy in the cage is eaten out quickly and the queen released very soon, this escort of worker bees may cause trouble. Should the colony be in a perturbed condition, they are by their odour recognised as strangers, and the animosity aroused is often transferred to the queen, while the latter, having some of her own bees round her, will be shy of strangers and frightened when getting amongst them. In introduction much depends upon the behaviour of the queen when first

released amongst the crowds of her new home. If the queen is removed from the escort of bees which accompanied her in the mailing cage (Fig. 1), and kept alone for half-an-hour, she will beg food of the first bee she comes in contact with, and this is always given her, and thus acquaintance made. For introduction by this method, what is known as Miller's introducing cage (Fig. 2) is used. (This may be obtained from the dealers in bee-keepers' supplies.) It consists of a thin wire gauze cage into which the queen only is put, the square hole at the end being plugged up with candy from the mailing cage and the cage placed horizontally between two brood-combs.

The queen will be fed by the bees through the wire gauze till released by the candy being eaten out.

Under very adverse circumstances, such as a dearth of nectar in the flora, robber bees in the apiary, or after wet extracted combs have been returned to the hives when nectar is not coming in freely, the methods of introduction usually employed often fail. If a queen *must*

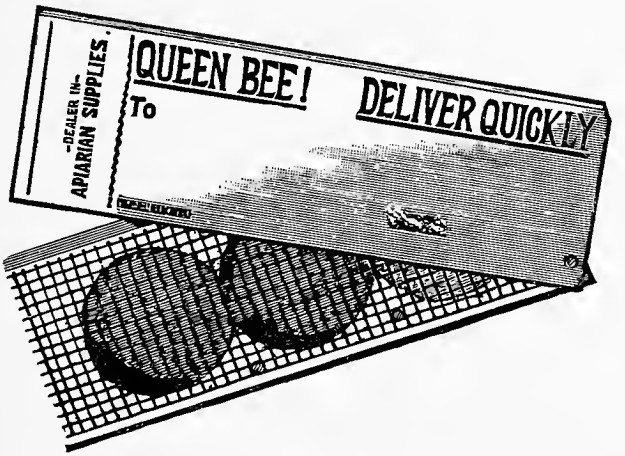


Fig. 1.—Mailing Cage.

be introduced, it is best, before attempting it, to remove all combs containing brood, except one which is left till evening to prevent the bees leaving and joining neighbouring hives. At dusk, shake the bees off this comb, give it to some other colony to take care of, and hang the caged queen between the broodless combs. When the brood is removed, the bees should be shaken off and the combs put on other colonies till after the new queen is safely laying, when they may be returned again without bees.

Success in introducing queens is assured largely by a minimum of interference and fussing. Most of the failures are due to two causes; either the colony has been kept open too long when hunting for the old queen, or it has been opened and examined too soon and at the wrong time after introducing the new queen. Over-anxiety of the bee-keeper for her safety often proves fatal to the queen. Under unfavorable conditions bees will sometimes ball their own queens

when the hive is opened, therefore a hive which has just had a new queen given to it should not be interfered with for at least four or five days, unless an unusual commotion at the entrance indicates that the queen is balled. If desirous of ascertaining whether the queen has been accepted, do so on the fourth or fifth day after the bees have ceased flying for the day.

If a queen is found balled, drop the ball of bees into a saucer full of water, when the bees will release the queen. If smoke is used to scatter the ball the smoker should not be held too close, as hot smoke may cause the bees to sting the balled queen. The queen should be re-caged in the hive, allowing the bees to again liberate her by eating out the candy.

Candy for Queen Cages.

The candy, the food supplied to queens and their escort of workers in the cages forwarded through the post, consists of a mixture of sugar and honey, in such relative proportions that it is much of the consistency of putty—it must be neither too stiff nor too soft. This candy is also used for introducing queens, by means of the Miller Introducing, or any other similar cage, and as food for bees in confinement. The direc-

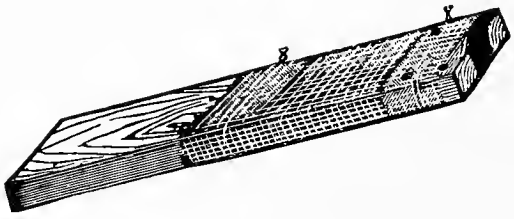


Fig. 2.—Miller Introducing Cage.

tions for making it given in textbooks are, to make a stiff dough out of good honey and powdered cane sugar. The honey is warmed till it is quite thin, and as much sugar as possible stirred in; it is then thoroughly kneaded with the hands, when it will gradually absorb more and more sugar. It should then be allowed to stand for some days, when more sugar should be worked in. Roots' *A. B. C. of Bee Culture* advises against the use of icing sugar, implying that it contains starch, and would prove fatal to bees. There is no risk of the kind in Victoria since the Pure Food Law has been in operation; the standard brands of icing sugar being quite pure.

The repeated working in of sugar, as described above, is laborious and tiresome. A candy equally good can be made in much less time, and in a single operation, by working the honey into the sugar instead of the sugar into the honey. It is done in the following manner:—Some good-quality honey is heated till it is thin, but not above 160° Fahr. Into a pudding basin, put 2¾ ozs. icing sugar, and rub it evenly fine, using a round-bottom lemonade bottle, or a delf door knob on a handle, as a pestle. Unless the icing sugar is very lumpy, this will only take a few seconds; then put 1 oz. of the hot honey into the sugar, stir till it becomes like oatmeal, and then work it with the pestle till it forms one

homogeneous mass, when it is ready for use; the whole operation having taken but a few minutes. The proportion of honey to sugar is as 2 to 5, or, as given above, 1 oz. honey to $2\frac{1}{2}$ icing sugar. It will be found best not to make it in larger quantities in one operation.

Quite the opposite to the American recipe, there should be somewhat less sugar in proportion to honey in summer than in winter. This difference is probably accounted for by the fact that candy here absorbs moisture from the atmosphere in winter, and gives off moisture to the very dry air of our summer—apparently the reverse takes place in America.

XVI.—Robber Bees.

Robber bees are not a different kind or strain of bees, as some bee-keepers assume; they are merely bees which have discovered that it is easier to carry home honey, the finished product, than to fly long distances to collect the raw material, the nectar of flowers, which, after it is taken into the hive, has to undergo a process of concentration and a chemical change, brought about by the addition of a nitrogenous secretion from the body of the bee. It is the presence in honey of this nitrogenous matter (albumen) which causes the excitement and the inclination to sting when bees find honey somewhere instead of nectar. When the available supply is exhausted, the bees will search near and far for more, and as they are guided by the sense of smell the odour of honey attracts them to the entrances of other hives, or bees nests in trees, and finding some poorly defended stocks they enter and empty the combs of the last drop of honey. Becoming bolder, the robbers next attack stronger colonies, with the result that much fighting takes place, and many bees are lost by stinging. Robbing, as a rule, starts during a dearth of nectar, or a temporary break in the honey flow; but once bees have been robbing for some time they will continue, even when nectar is plentiful again, and it is about as difficult to cure them of the robbing habit as it is to break a dog of worrying sheep, or a hen of eating eggs.

Causes of Robbing.

There are quite a number of causes which develop the robbing habit in bees, the underlying factor in every instance, however, is that the bees find or scent honey instead of nectar. 1. Bees should on no account be allowed access to honey outside their own hive. The decimation of box hive bees over the larger part of Australia during the past 30 years is almost entirely due to the practice of letting the bees clean up rejected combs, sticky boxes, and utensils after the hives have been robbed of their contents. If one of the robbed hives happened to be diseased, many, or all the colonies, would get a share of the infected honey, while bees from trees or neighbouring farms would also take part, with the result that foul brood almost annihilated bees in some districts. 2. Feeding bees outside the hives during a dearth of nectar, or, indeed, at any time, is a bad practice, and frequently causes robbing to start. If it is necessary to feed it should be done inside the hive, a proper feeder being used, and sugar syrup given, not honey; the former is just as good as honey, is cheaper, safer, owing to the absence of possible disease germs,

and does not excite the bees so much, as it does not contain any nitrogen. Even then it is best to give the syrup towards evening, so that bees from other hives may not be attracted. 3. Combs in hives, the walls of which are too thin, sometimes melt down in hot weather, and the honey running out, attracts bees from other hives. 4. Weak colonies, which are unable to guard the hive entrance efficiently, or queenless colonies, which will admit strange bees, robbers included, without hindrance, may also, during a scarcity of nectar, cause an outbreak of robbing. 5. Unseasonable operations are frequently the cause of robbing. Shaking the bees off the combs in front of the hive instead of into the hive, and thus spilling thin honey on the ground, extracting honey in the open air, or in a non-bee proof room, and returning extracted combs to the hives, are all operations which are quite harmless during a honey flow, but which, after a change in the weather, may create quite an uproar in the apiary. The secretion of nectar by the blossoms sometimes suddenly ceases when extracting still has to be done, and it is, therefore, best to have a bee-proof place to extract in, to shake the bees off the combs into the hives, and not to put the extracted combs out till towards evening.

Results of Robbing.

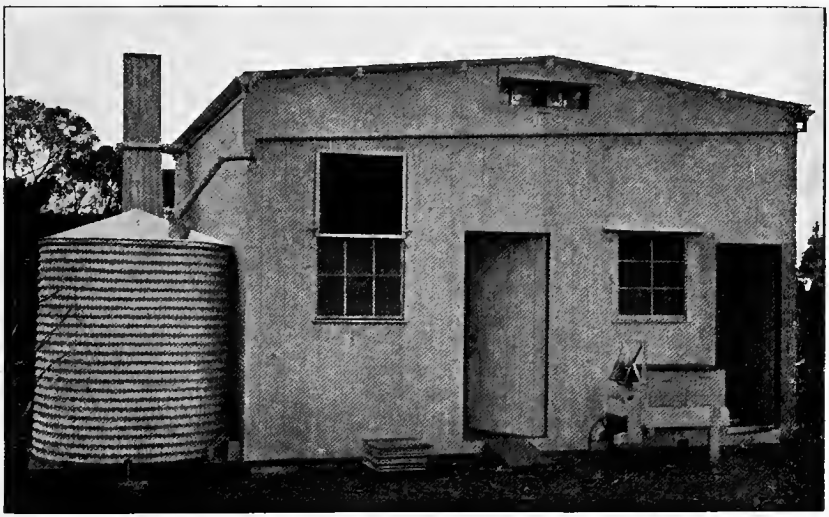
It has already been stated that robbing has caused, and, it may be added, is still causing the wholesale spread of the diseases of bees, and while the loss of many colonies from foul brood is the most deplorable of the results, there are others, some of which are annoying, while others add expense to the running of an apiary, or reduce the returns. Robbing is almost invariably accompanied by the stinging of man and beast in the vicinity of the hives, while sometimes the actual loss of bees stung to death is considerable.

When an apiary has become demoralized through robbing, even bees, which, by mistake or on account of strong winds, enter the wrong hive are stung to death, when under ordinary conditions they would be accepted. It is stated in some bee books that every bee knows its hive, but every careful observer who has kept several distinct races of bees in the same apiary knows that there is considerable straying of bees from hive to hive. In a demoralized apiary, every strange bee entering a hive is stung, and large numbers of dead bees may be seen in front of every hive long after actual robbing has ceased. Further, when bees are in this state of irritation they will sometimes ball their own queen, or, if a virgin, cripple her so that she is unable to take her mating flight, or destroy her altogether, so that the colony becomes queenless, and a further inducement to create robbing. At such times attempts to introduce new queens are sure to result in failure, the owner of the bees being at a loss how to account for it.

Prevention of Robbing.

In regard to robbing, as in other things, prevention is better than cure. If the extent to which bee-keeping is carried on does not justify the erection of a special bee-proof extracting house, at least a place should be set apart which can be made bee tight in which to carry out all the operations of uncapping, extracting, and tinning of honey, and

to store combs, wax, and appliances. Even a tent may, with little trouble, be made bee-proof. For the specialist bee-keeper, a properly constructed honey house is an absolute necessity, and a good investment, as it enables him to catch up with the work of extracting during short breaks in the honey flow, when otherwise he could not do so without demoralizing the bees. When more than twenty hives are kept, a wheelbarrow constructed on the lines of that shown in the illustration, carrying four supers of combs, will save much time and hard work, and at the same time exclude the bees from the combs during the taking of the combs from the hives and on the way to the extractor. This is accomplished by having a board the size of the hive body, with a rim round the edge, on the barrow to catch any drips of honey, and a light cover on top, which is raised and dropped again every time a comb is inserted. If robbers are very persistent, and try to rush the combs every time the cover is raised, they may be circumvented by using two smokers, one



Bee-proof Honey House and Hive Barrow.

at the hive, while the other, with the top open, is placed on the ground inside a hive body, another body is placed on top, into which the combs are hung as they are taken off the hive; no cover is needed, as the smoke rising between the combs keeps the robbers away. When the box is full it is lifted on to the barrow and covered up. In this way honey may be taken off and extracted at times when it would be impossible to do it in the ordinary way without starting robbing, stinging, and general confusion amongst the bees.

Water in which sticky utensils have been washed, or the water used in boiling up old combs or beeswax, should be buried, while the refuse from the wax press, or the bag in which wax has been boiled under water, should be burned. The exercise of these precautions will keep the largest apiaries in a normal state, and enable all work to be done in peace and comfort.

To Stop Robbing.

When robbing has only just commenced it may often be stopped. If a weak hive is being attacked, the entrance should be contracted, to give the defenders a better chance of repelling robbers. If robbers are hovering round or bunching on the crevices between the lower and upper story, a little kerosene or carbolic acid applied to the wood with a brush will cause them to desist. If contracting a hive entrance is not effective, the same remedy may be applied, taking care not to put it too close to the entrance. The uninitiated often find it difficult to distinguish robbers from the bees belonging to the hive, and it may here be pointed out that a robber is easily recognised by the way it carries the third pair of legs while on the wing. Ordinarily, the hinder legs are not very noticeable on a bee in flight; on a robber bee they are very conspicuous, being extended full length backwards and outwards. When robbing has only just started, the robbers may all come from one or two hives. To discover from which, put some flour in the entrance of the hive that is being robbed, and then walk round the other hives and look for returning flour-bedaubed bees. If it is only a case of one colony robbing another, changing the places of the two hives will confound the robbers and restore order.

XVII.—Feeding Bees.

Feeding bees is carried out in Europe and North America to a far greater extent than in Australia, where nature nearly always provides the necessary supplies; only twice has it been necessary to supply the bees with artificial winter stores in the writer's twenty-seven years of bee-keeping.

Feeding is done for three distinct purposes. (1) To stimulate brood-rearing, (2) to tide over a period of dearth during the working season, and (3) to supply the colonies with winter stores.

Stimulative Feeding.

This is practised in Europe and very extensively in the United States of America. The object is to have a stronger force of worker bees in the hives by the time an early honey flow is expected than could possibly be present if the colonies were left to develop naturally under the influence of the gradually rising temperatures of spring. The feeding in this instance consists in giving each colony daily a small amount of sugar syrup of equal weights of sugar and water, given blood-warm in a feeder inside the hive, preferably towards evening. Feeding should commence five to six weeks before the honey flow, so that most of the bees raised will be of field age when the expected flow is at its best.

In Victoria, in normal seasons, there is sufficient natural stimulation early enough in spring to fully develop the strength of the colonies for the main honey flow without resorting to artificial stimulation if the bees are favorably located during the winter and early spring. In localities where an early honey flow occurs it may, however, yet be found that stimulation feeding, judiciously done, would be very profitable.

Starvation Feeding.

This is done to tide the bees over a period of complete dearth of nectar such as sometimes occurs even in midsummer, caused by a break in the succession of flowering eucalyptus, or by a spell of cold weather extending over many days. Under these conditions bees will cease breeding altogether, and may even throw out all young brood unless promptly given food.

The generations of bees missed through a stoppage of brood-rearing or destroyed for lack of stores will be badly missed in a honey flow a month later. The remedy is to give each colony one comb of honey if such has been kept on hand for such an emergency; if not, to give each a dose of sugar syrup, ½ pint to 1 pint, according to the strength of the stock.

Feeding for Winter Stores.

As indicated before, it does not often become necessary to supply artificially the amount of stores of honey necessary to safely bring the colonies through the winter and ensure their normal development in spring. The wintering problem as found in most parts of the northern hemisphere does not exist here; still, a certain amount of attention is required at the end of the season, which, unfortunately, is too often not given, with the result that, although the bees in most instances struggle through somehow, the development of the colonies in the following spring is greatly retarded and interfered with, by the absence of sufficient good stores, by too much space and the scattering of the stores (often of watery honey) in too many combs.

The ideal condition for winter is to have each colony in a single story, on just as many combs as the bees can cover, and these combs well filled with sealed honey or syrup. In seasons when the honey flow declines gradually, this condition is obtained by taking all supers off before the flow is quite over, when the usually thin nectar will be stored in the combs covered by the bees, and there ripened and sealed, instead of in the super combs, where it would candy or sour during winter, and causing, when consumed later on, dysentery amongst the bees.

When the honey flow ceases suddenly, the brood combs will often be found with much brood but very little honey when the supers are removed. It then becomes necessary to supply the bees with sufficient good winter food to carry them through till spring. The amount will vary, according to the strength of the colony, from 20 to 40 lbs. of sealed honey or syrup.

If the apiary has been free from foul brood for several seasons, any thin honey found in the combs of the supers which were taken off may be extracted, and, after being heated to 170 deg. Fahr., fed back to the colonies till each has enough. Colonies below the average strength, which cannot properly ripen any honey or syrup given them, it is best not to feed, but to supply them with stored and sealed or partly sealed combs from stronger colonies abundantly fed. If there is suspicion that foul-brood germs may be present in any of the combs, it will be best not to feed back any of the honey extracted, but to give instead a syrup made by dissolving 2 parts of 1A sugar in 1 part (by weight) of boiling water. Even with sugar at 17s. 6d. a bag, sugar syrup is

cheaper than and just as good as honey of the same density, while all risk of infection is avoided.

Feeding for winter stores should be done rapidly, and while the weather is still fairly warm. The syrup (or thin honey) should be given blood-warm, and of the density given above (2 lbs. of best sugar to 1 lb. boiling water). All feeding should be done inside the hive, with the twofold object of keeping the food warm as long as possible and of preventing the access of bees from other hives.

As feeding for winter stores is so seldom required, there are perhaps few apiaries in which the necessary feeders are on hand. To make

Fig. 1.—Simplicity Feeder.

sufficient feeders for a fair-sized apiary would take some time and considerable material, and on this account the bees are sometimes left to take their chance. at times when prompt feeding at the right time would insure their safe wintering, and a vastly greater honey crop in the following season.

The Simplicity feeder, as sold by supply dealers (Fig. 1), while quite suitable for stimulative feeding, is altogether too small for feeding winter stores. The frame-feeder (Fig. 2), while still somewhat on the small side, is more suitable, but rather expensive. The writer,

Fig. 2.—Frame Feeder.

when suddenly confronted with the problem of feeding a large number of colonies heavily in a short space of time, used 7-lb. honey tins for this purpose. All that is necessary is to have for each tin a piece of thin board 6 inches by 6 inches, to which is nailed a rim $\frac{3}{8}$ inch thick and $\frac{1}{2}$ inch deep, with hot wax run all over joints to make them watertight. The lever tops are removed from the tins; if the tins have wire handles, these are pulled out, and the clips holding them bent down so that the tin will stand level when upside down. A few holes are punched into the side of the tin with a 1-inch nail, as near the top edge as possible. The tin is then filled with syrup, the rimmed board

put on top (rim downward), and, while holding the tin from the bottom with one hand and pressing the board on tightly with the other, the tin is swiftly turned upside down and stood on a level surface. The little shallow trough formed by the board will be full of syrup up to the top of the holes punched into the tin. When placed on the top of the brood frames, as shown in the illustration (Fig. 3), as the bees sip up the syrup more will ooze out, till the tin is empty. Of course, the top of the brood frames should be level in all directions, otherwise all the syrup will run out if the inverted tin stands very unevenly.

A super from which a sufficient number (or all) of the frames have been removed is put over the tin or tins, and the hive cover on top. Several tins, sufficient to supply the needs of the colony, can be put on at the one time, and any kind of round tin can be used, washed out

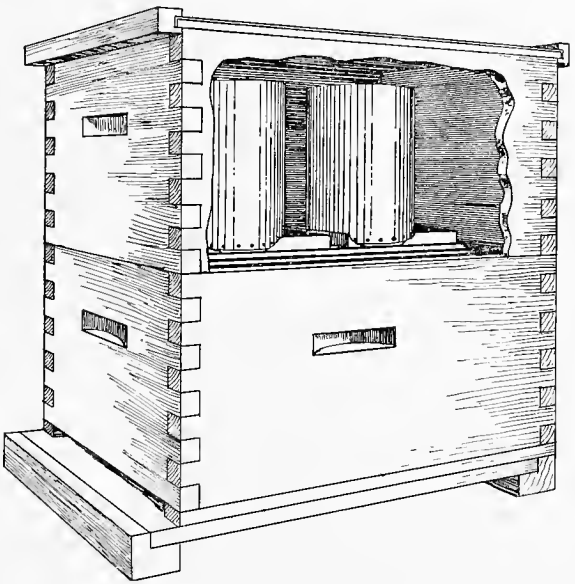


Fig. 3.—Inverted Honey Tin Feeders on Hive.

afterwards, the fine holes closed with solder, and the tins used for packing honey. Square or flat tins are not suitable, as the sides give way inward, and allow too much syrup to escape.

XVIII.—Wintering Bees.

At the end of the honey season every bee-keeper should make a thorough examination of his stock to ascertain whether each colony has a fertile queen, a sufficient force of worker bees, and enough honey to carry him through till September or October. To get bees successfully through the winter months is a most difficult problem in North America and Northern Europe, especially where the rigour of the climate makes cellar-wintering almost a necessity.

In Australia, we have no such difficulties, and in consequence bee-keepers pay too little attention to the subject of wintering so far as the condition of their colonies at the beginning of winter is concerned. Yet it is the condition of a colony, as to quantity and quality of stores, age and vigour of queen, and number of worker bees at the end of one season, which largely determines the prosperity of, and the yield of honey from, that colony in the season following.

The first consideration is the amount of honey required by each colony for its winter use. This varies according to the strength in bees, the conditions of weather during winter, and the earlier or later presence in spring of nectar and pollen-producing flowers. On an average each colony should have from 25 to 30 lbs. of sealed honey to winter normally. When, as sometimes happens, the brood combs contain considerably less than that quantity, it will have to be supplemented either by substituting combs of sealed honey for the outer empty combs of the brood chamber, or by feeding sufficient honey or sugar syrup to bring the total quantity up to requirements.

Giving combs of sealed honey, which have been put by for that purpose during the season, is the easiest way of supplementing winter stores, but it should not be practised unless the apiary is, and has been for some time, entirely free from foul-brood, as in this interchange of combs there is always a risk of spreading disease. When, owing to the absence of a stock of sealed honey, or on account of a suspicion of disease, it becomes necessary to feed, sugar syrup is much to be preferred to honey. Honey, although it is the natural food of bees, excites them much more than sugar syrup. There is also the risk of introducing the germs of brood diseases with honey of unknown origin, while its stronger odour may attract bees from other hives, and thus cause trouble by starting robbing.

Feeding should always be done inside the hive in a properly constructed feeder. In the case of colonies which do not cover all the combs of the brood chamber, some of the outside combs may be removed before feeding is commenced, so that the whole of the syrup given will be stored in as few combs as possible, and where it will be covered by the cluster of bees, and thus prevented from souring.

Sugar syrup is made of two parts (by weight) of 1A sugar and one part water. The water is brought to boiling point and the sugar added, keeping the vessel on the fire and stirring continuously till the liquid is perfectly clear. On no account should the syrup be left on the stove or fire without stirring, as it burns very easily, and in that state is injurious to bees.

To supply this syrup to the bees without waste and drowning it is necessary to have a feeder. Fig. 1, known as the simplicity feeder, may be purchased of a supply dealer at 4d. It is a block of wood, grooved out so as to leave narrow divisions to prevent bees getting drowned. This is the most convenient form of feeder for box-hives. The box is raised at one end, the feeder placed on the floor board, and the syrup poured in while still warm; the box is then lowered again. If a stock of bees is quite out of stores, at least 5 lbs. of syrup should be given and more later on, if required. It will be better to give the syrup as fast as the bees will take it than to continue feeding for days; for the longer the excitement lasts the more food is consumed without purpose.

Colonies fed during winter cannot be given sufficient food for breeding up in spring, but only enough to carry them along till warmer weather. They should therefore be examined periodically whenever a fine day permits, and another dose of syrup given when needed. When pollen is being carried into the hives, a sign that brood-rearing has commenced, the stores of syrup will be consumed much faster, and care should be taken that after bringing the bees through the winter they do not succumb to starvation in early spring.

In Victoria, the necessity for winter feeding rarely occurs, unless hives have been robbed or extracted without regard to the winter requirements of the bees

Packing of hives, as practised in colder countries, is not necessary here, but upper stories of empty combs should be removed from the hives, taken indoors, and stacked up and secured against bee moths. The removal of all spare combs and boxes does not only prevent loss of animal heat by radiation, and the unnecessary consumption of stores to replace this loss, but it also compels the bees to store any thin honey, which they may still gather, into combs covered by bees; it will there ripen, instead of souring as it does when stored in combs outside the cluster of bees. Watery honey, when consumed during inactivity, is without doubt detrimental to bees, particularly when it contains such a high percentage of nitrogenous matter, as is present in the honey from our winter-flowering iron-bark trees. The consumption of watery food during winter causes ordinary dysentery, and probably also provides a suitable medium for the multiplication of the *Nosema apis* parasite and the growth of fungi in the intestinal tract. At the same time, the more rapid accumulation of fæcal matter in the intestine compels the bees to take cleansing flights during unsuitable temperatures, resulting in loss through chilling and failure to return to the hive.

Methods of wintering differ with bee-keepers, and also in localities. Some leave the supers on the hives whether full or empty, others put the empty stories underneath the brood chamber, while yet others remove the supers altogether and shut the bees down on the combs of the single brood chamber.

With a favorable winter and colonies strong, there is little, if any, difference between the three methods. But colonies are not always strong at the end of the honey season, and the character of the coming winter cannot be anticipated. It is therefore best to take no risks, but shut the bees down to a single story, which will give the best results under all the varying conditions of strength in bees and climatic influences. When colonies are left with one super full of ripe honey, in addition to the brood chamber, they winter well. But not many bee-keepers are prepared to leave so much honey in the hives, which is not needed by the bees and represents in a large apiary a considerable money value which cannot be realized till the following spring. At the same time, there is a risk of some of the honey granulating in the combs, and then it cannot be obtained except by the destruction of the combs.

When supers with empty combs are left on, the heat generated by the cluster of bees escapes upwards and the bees sometimes follow it and establish their seat between the empty combs. Some of the honey is carried up by this means and the operation causes unnatural activity, greater consumption of stores, and wearing out of bees.

With the empty combs put below the cluster of bees, the same advantages of conserving heat and ease of occasional examination are secured, as when bees are wintered in a single hive body. But combs below the brood are apt to become rather dirty, and sometimes mouldy.

Since it has become known that the *Nosema apis* parasite is present in almost every apiary, there is an additional reason for the removal from the hives of all combs not required by the bees during winter. According to Dr. Zander, the discoverer of *Nosema apis*, the chief source of infection is the combs soiled with the fæces of diseased bees. During the working season, bees void their excrements outside the hive; moreover, the life of the bee during active field work in summer is so short that infected bees wear out in the natural course of events before the disease has reached the final stage, as in the case of bees which came through the winter.

The removal of all surplus combs, at the end of the season, will therefore do much to keep them free from the infection, which un-

Apiary Showing Hives Shut Down for the Winter.

doubtedly would take place during winter should an outbreak of malignant dysentery occur. Thus, only one set of combs would have to be boiled down, instead of two or more. In the case of small colonies, the reduction can be carried still further. The writer has repeatedly successfully wintered bees on three or four combs by confining them to one side of the hive (the side facing the sun) by means of a division board, or by putting two small stocks into one hive, a thin tightly fitting board and a separate entrance for each, keeping them apart.

This crowding of bees on a limited number of combs has also the advantage of being a preventive of robbing. Robbing generally gets started, in the first instance, by bees prowling round and finding honey in the unguarded outside combs of a colony. Becoming bolder, by degrees, the robbers will attack any poorly defended hive. Bees from

other hives, attracted by the commotion, join in and share in the plunder. As colonies affected with foul brood are poor defenders of their home, such a colony, if one is in the apiary, usually falls a victim to the robbers and the robbers in turn develop disease in their hives. Combs removed from the hives should be at once secured from access by bee moths, by tiering the cases and securely covering the top and bottom of each stack. It is during the autumn that the wax or bee moth deposits its eggs on the combs, although the grubs do not appear till spring. Often the bee-keeper is unaware that the eggs were present when he carefully packed away his combs, after leaving them exposed to the moths for a little time.

XIX.—Diseases of Bees.

The diseases affecting bees may be grouped under two headings, viz., diseases of the adult bee and diseases of the larvæ, or brood. The latter diseases are the more generally distributed and serious, and the principal ones are known under the general term of foul-brood of bees.

Foul-brood.

This is a contagious disease which kills the young larval bee in the cell. By contact with the remains of the dead grub the disease is transmitted by the adult bees to other cells, thus causing the death of the larvæ from eggs deposited in such cells or the contamination of any honey stored in them.

As the average life of the worker bee during summer is only six weeks, it follows that the number of young bees hatching decreases as the disease advances, the colony soon dwindles in numbers until it finally dies right out or becomes so weakened as to be unable to defend itself against robber bees from other hives. The honey is carried away by bees from other colonies, which in turn become infected, thus propagating the disease indefinitely.

The methods of box-hive bee-keepers, however, have done more to spread disease than anything else. The usual way is to drum the bees out of the upturned hive into an empty box, to cut out the combs, and, after crushing them and straining the honey off, to throw out the residue, and any combs too black for straining, for the bees to clean up. If any of the hives were diseased, the germs are at once re-introduced into the newly-built combs of the robbed hives, while the contaminated honey, when marketed, carries infection to distant localities by means of bees getting access to retail packages after they have been emptied and thrown away.

The cause of foul-brood is a micro-organism growing in the tissue of the larvæ of the bee and sometimes also in the adult insect. It was named *Bacillus alvei* by Cheshire and W. Cheyne in 1885. Since 1912 American investigators have discovered that there are three types of foul-brood, European Foul-brood caused by *Bacillus pluton*, American Foul-brood caused by a micro-organism differing from the former and named *Bacillus larvæ* by Dr. G. F. White, of United States Department of Agriculture, and Sac-brood caused by a filterable virus. The general appearance of the diseased brood is, however, the same in all,

and the same treatment is necessary to effect a cure. Whether foul-brood in Australia is caused by *B. pluton* or *B. larvæ* has up to the present not been scientifically tested; probably both are present.

To describe diseased brood to any one not well acquainted with the subject it is best to contrast its appearance to the eye with that of brood in a healthy state. Normal healthy brood shows in compact masses in the comb, that is to say, considerable numbers of adjoining cells contain larvæ of the same age (Fig. 1). In a diseased comb the brood appears irregular and scattered. Healthy larvæ are of pearly whiteness, plump, and lie curled up on the cell bottom almost in the shape of the letter C. Diseased larvæ are pale yellow, and, further on, turn brown; the grubs appear flabby, and are not so much curled up as healthy larvæ of the same size.

When the larvæ do not die till after the cells have been capped over, cells will be found here and there darker in colour than healthy

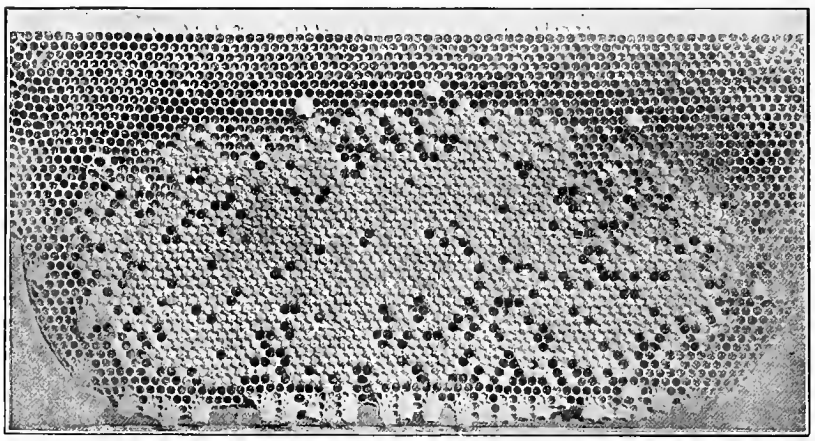


Fig. 1.—Comb of Healthy Brood; Queen Cells also Shown.

ones alongside; the cappings usually will be indented instead of convex, and will frequently show irregular holes. (Fig. 2.) If these cells are opened, a brown mass is visible which, when touched with a match or straw, draws out stringy or ropy. The ropiness is the surest practical way of identifying the disease, and the test should be applied to any suspicious-looking cells which may appear amongst the brood. I would here point out that, although the cappings of brood, particularly those of black bees, have, when healthy, the appearance shown in Fig. 1, there are some bees of the yellow races which cap the cells quite flat; also, that the scattering of the brood is by itself not necessarily an indication of disease, and may be due to the irregular laying of an inferior queen.

In view of the heavy losses resulting from foul-brood, when once it has obtained a good start in an apiary, and the great amount of labour involved in its eradication, as well as to the fact that it has

now been proclaimed a disease under the *Bees Act* 1910,* it is desirable that every owner of bees should be able to recognise this disease when it appears in one or more of his hives. He will then be able to deal with it before it has made any great headway.

Unfortunately, there are still many bee-keepers who do not discover the presence of this disease amongst their bees till the small number of bees in several of the hives indicates that there is something wrong. When hives have been affected sufficiently long to show marked decline in the number of bees, the disease is likely to spread rapidly; the remaining bees are usually inactive, and do not defend their hives against robber bees from strong healthy colonies, which in turn fall victims to foul-brood. It is, therefore, important that vigilance should be exercised whenever combs are handled, so that the disease may be discovered and treated when still in its first stage.

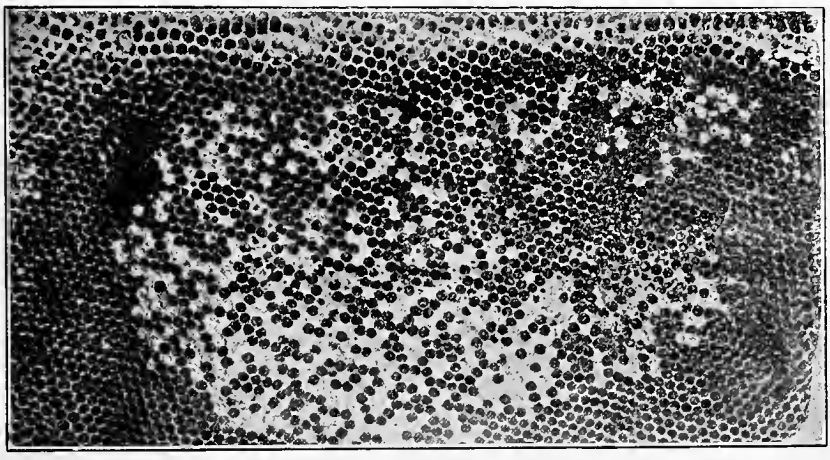


Fig. 2.—Comb of Diseased Brood, Showing Flat, Sunken, and Perforated Cappings.

When foul-brood is discovered, the affected hive should be at once covered up again to prevent attracting robber bees from other hives; and unless the colony is still strong in bees the entrance should be contracted to from 1 to 3 inches in width, so that the diseased colony may be better able to defend itself against robbers. The brood in the other hives of the apiary should be carefully examined, taking care not to attract robbers by leaving a hive open too long or performing the examination at unsuitable times. If more cases are found, the hives should be marked and treated at the first favorable opportunity.

* Under the *Bees Diseases Act* 1910 it is provided that the Governor in Council may by proclamation declare as disease any pest, &c., for the purposes of the Act. In this respect Foul Brood *Bacillus alvei*, Brood Pest *Bacillus larvæ*, and Sour Brood *Streptococcus apis* have been so proclaimed. By the Act an inspector is empowered to enter and inspect any premises where bees are kept, and take such action as is necessary to arrest the spread of disease by cleansing or disinfecting or destroying such articles or appliances, or bees, hives, comb, or honey as are likely to spread disease; and any owner neglecting to carry out the directions of an inspector is liable to a penalty for an offence against the Act. On and after 1st January, 1913, any district may be proclaimed a district in which no bees shall be kept except in certain prescribed hives.

To successfully cure a colony of foul-brood three conditions are necessary, viz., first, there should be sufficient bees in the diseased colony to form a small swarm; second, the weather should be mild or warm; and third, honey should be coming in. If sufficient bees are not left in a diseased colony to build combs and to raise sufficient brood to increase the worker force, no cure should be attempted; it will be found more profitable to at once destroy by fire the bees, combs, and frames.

Warm weather is required to enable the bees to secrete wax and rear brood, and therefore bees cannot be treated before September or after March. A honey flow is essential, so that bees treated may not be robbed during or after treatment.

The only reliable method of getting rid of foul-brood without destroying the entire diseased colony is to remove the bees from their infected surroundings and start them afresh in a clean hive.

This is done by putting a clean hive with frames supplied with starters of comb foundation on the spot occupied by the diseased hive, removing the latter to a little behind the former. A cloth or bag is placed in front of the clean hive, on to this the bees are rapidly shaken and brushed from the diseased combs. If they do not readily enter the new hive, a little smoke may be used to drive them in. The bees will now start comb-building; the honey which they brought from the diseased combs in their honey sacs will be consumed in the secretion of wax, and the colony will now be free from disease, unless it is reintroduced into the hive from outside. To prevent the bees swarming out and absconding, as they will sometimes do when suddenly deprived of their brood, queen-excluding zinc may be fastened over the entrance, so that when the bees swarm out the queen cannot follow, and the swarm will return to the hive. This obstruction should, however, be removed in four or five days, when the bees will have settled down.

The diseased hive, floor, cover, and frames of comb should be taken indoors as soon as the operation of shaking down is finished, and effectively secured against access by bees. The combs and frames should be at once destroyed by burning. The hive, hive floor, and roof should be thoroughly cleansed by immersing and scrubbing in boiling water containing washing soda and soap. When clean, the hive should be exposed to the atmosphere to dry thoroughly, after which it may again be used for housing bees.

When only a few diseased cells are found in a number of hives, the strongest of them may be treated first, and the brood combs given to the other affected colonies in a super over a queen-excluding honey board. In ten days most of the healthy sealed brood will have hatched, increasing the worker-force of the remaining diseased colonies, which may now also be cured by the shaking-down method described before.

To completely destroy a diseased colony which is too weak to be cured, close the entrance of the hive when the bees have ceased flying towards evening. Put sufficient wood, ready for lighting, into a hole dug for the purpose, place the hive on the fuel and set fire to it. When burned down, fill up the hole with earth. The combs removed from hives shaken down should be destroyed in the same way, otherwise

there may be difficulty with bees getting access to honey which remained unconsumed by fire.

Observance of the following rules will greatly assist bee-keepers in the prevention of foul-brood and its eradication when present in the apiary:—

1. Have no queenless colonies; they will not defend their hives, and will thus establish robbing habits in the apiary.

2. Do not allow bees to have access to honey, combs, wax, or hive refuse, even when quite free from disease; bees should know of no other source than the nectar of flowers.

3. Never feed honey to bees; it may contain disease germs; it excites them and induces robbing. Sugar syrup is safer, cheaper, and just as good for feeding.

4. Do not try to cure foul-brood by requeening alone, or by doctoring diseased cells, or cutting them out. It will only delay the course of the disease, but will not cure it.

5. When examining combs for disease, do not use your finger nail to open the cells, but a match, toothpick, or straw. Use a fresh one for each hive, and burn those used.

6. Do not try to cure the disease by giving the bees medicated food. Any drug given strong enough to destroy the germs of foul-brood would kill the bees.

7. Do not interchange combs between different hives while there is disease in the apiary.

8. If bad weather should set in after a diseased colony has been treated, feed sugar syrup (1½ sugar to 1 water) inside the hive.*

A disease of the brood of bees which, while somewhat resembling foul-brood in appearance, but without the characteristic ropiness of the dead larvæ, has for some years attracted the attention of bee-keepers in other countries. That this disease is distinct from foul-brood is proved by the fact that in the study of samples carried out by Dr. G. F. White, of the United States Bureau of Entomology, no micro-organisms were found either culturally or microscopically.

This disease is present in Victoria, and, as it will sometimes entirely disappear or yield to the cutting out of the affected brood, the temporary success of this superficial treatment has, in some cases, caused the adoption of this method for the treatment of foul-brood, for which it was mistaken by bee-keepers.

Even when this disease disappears without treatment, it may reappear the next season. As it has been proved to be infectious, bee-keepers are advised to treat affected colonies in the same way as those suffering from foul-brood; that is, by the removal of all infected material from the hive.

Dr. G. F. White commenced the study of this disease in 1902. In a pamphlet just issued by the United States Department of Agriculture he gives it the name of sacbrood, on account of the sac-like appearance of the dead larvæ, which can be removed from the cell without rupturing their body wall.

* See Feeding, pages 72–73.

Sacbrood.

On page 3 of the pamphlet referred to, Dr. White, concerning the symptoms, says:—

"The strength of a colony in which sacbrood is present is frequently not noticeably diminished. When the brood is badly infested, however, the colony naturally becomes appreciably weakened thereby. The brood dies after the time of capping. The dead larvæ are therefore almost always found extended lengthwise in the cell and lying with the dorsal side against the lower wall. It is not unusual to find many larvæ dead of this disease in uncapped cells. Such brood, however, had been uncapped by the bees after it died. In this disease the cappings are frequently punctured by the bees. Occasionally a capping has a hole through it, indicating that the capping itself had never been completed. A larva dead of this disease loses its normal colour and assumes at first a slightly yellowish tint. 'Brown' is the most characteristic appearance assumed by the larva during its decay. Various shades are observed. The term 'gray' might sometimes appropriately be used to designate it. The form of the larva dead of this disease changes much less than it does in foul-brood. The body wall is not easily broken, as a rule. On this account often the entire larva can be removed from the cell intact. The content of this sac-like larva is more or less watery. The head end is usually turned markedly upward. The dried larva or scale is easily removed from the lower side wall. There is practically no odour to the brood combs.

"The Infectious Nature and Cause of Sacbrood.

"In the study of samples of this disease received directly from bee-keepers no micro-organisms have been found, either culturally or microscopically, to which the cause of the disease can be attributed. This fact, together with the fact that the disease often disappears without any great loss to the colony, would tend to indicate that the disease is not infectious. The experimental evidence which I have obtained proves, however, that the disease is infectious.

"Experimental Work with Sacbrood.

"Evidence has been obtained by me that sacbrood can be transmitted from diseased to healthy brood. Three healthy colonies were inoculated, each with diseased material from a different locality, and in each of these three experimental colonies the disease was produced. These results indicated at once that sacbrood is an infectious disease. The microscopical and cultural study of the infected and dead brood in these experimental colonies, as in the case of the diseased brood in samples direct from the apiary, failed to show any organism to which the cause of the disease could be attributed.

"This led naturally to a study of the condition to determine whether or not the virus of the disease was so small that it had not been seen. To obtain evidence on this point material containing the virus was filtered using an earthenware filter. The three colonies in which the disease had been produced experimentally furnished the disease

material for the experiments. Larvæ, sick and dead, of sacbrood were picked from the combs, crushed, and diluted with sterile water. This suspension was filtered by the use of the Berkefeld filter. From each of the three diseased colonies a separate filtrate was obtained, which was fed in syrup to healthy colonies. Six colonies were thus fed—two with each of the three separate filtrates. As a result of these inoculations sacbrood with typical symptoms of the disease was produced in all of the six colonies thus fed.

"One more experiment will be mentioned at this time. In this the diseased brood used was taken from one of the colonies in which the disease had been produced by feeding filtrate. Disease material from this colony was filtered as before and fed to two healthy colonies, with the result that sacbrood was produced in each. It might be mentioned here also that other experiments made indicate that the virus is killed by the application of a comparatively small amount of heat.

"In eleven colonies, therefore, sacbrood has been produced experimentally by feeding to healthy colonies the virus of this disease. In eight of the eleven colonies the disease was produced by virus that had passed through the Berkefeld filter. The disease, therefore, which bee-keepers have for a long time recognised as being different from either American or European foul-brood, has now been demonstrated to be an infectious disease that is caused by a filterable virus.

"The conclusion to be drawn from this work, therefore, is that sacbrood is an infections disease of the brood of bees caused by an infecting agent that is so small, or of such a nature, that it will pass through the pores of a Berkefeld filter.

"The three principal brood diseases, then, are now all known to be infectious. These diseases are—American foul-brood, caused by *Bacillus larvæ;* European foul-brood, caused by *Bacillus pluton;* and sacbrood, caused by a filterable virus."

Diseases of Adult Bees.

While the causes of brood diseases of bees are well known, the state of our present knowledge of the diseases of adult bees is much less satisfactory. The latter are three in number—Paralysis, dysentery, and disappearing trouble.

Bee Paralysis.

This is a disease of the adult bees, the cause of which is still unknown. The first indication is the presence in the colony of a few shiny, emaciated looking bees; these are still capable of flight, and some will go foraging, but they often fail to return, remaining on flowers and other objects and die. Later on numbers of bees with abnormally inflated abdomens will be noticed in the hive. They may be noticed about the hive entrance, their wings and legs extended sideways, giving them a sprawling appearance. Their movements are jerky, and their wings quiver at intervals. When a hive is opened some of the bees so affected will, after a few minutes, come on top of the frames. When smoke is blown amongst the bees they remain on top, while the healthy ones run down between the combs. After paralysis has been present in a colony for a considerable time even the

newly-hatched bees may become infected. They crawl from the hive, fall over on their side or back, just move their legs now and again, and do not die till many hours later. In the case of these young bees, there is no swelling of the abdomen and no quivering of the wings.

Paralysis in Victoria is more prevalent north of the Dividing Range than in the coastal country, but whether this is due to climatic influences or to variations in the food supplies is not known. Many remedies have been advocated, such as sprinkling the bees with sulphur flour, spraying them with brine, or feeding medicated syrup, and although the disease is often checked for a time, no cure is effected. When using sulphur the brood should be removed, as otherwise the sulphur will kill all the unsealed brood and eggs. The brood removed may be given to any other colony without risk of infecting it, provided care is taken to shift none of the adult bees with the combs. There is no doubt that some strains of bees are predisposed to paralysis, and the only treatment known to be at all effective is to kill and replace the queen of every hive showing the first symptoms of the disease, and thus gradually eliminate it. If the new queen is of the same strain, or of another one equally predisposed, no cure will result. In obtaining queens from elsewhere for the purpose of re-queening colonies showing paralysis it will be better to get them from an apiary from which the disease has been eliminated than from one in which it has never made its appearance, because in the former the queens would be from stock which proved immune in contact with the disease, while in the latter there has been no such test.

It is of the utmost importance that on no account should queens be raised or kept from stocks which show signs of paralysis, no matter how desirable they may be in all other respects; further, the queens of all affected hives should be replaced as soon as possible, to prevent the raising of predisposed drones, which by mating with the young queens would perpetuate the weakness in the apiary.

Dysentery.

The symptoms of dysentery of bees are the soiling of the hive entrance and the immediate surroundings with the watery excrement of the bees. This is brownish-yellow, and has a disagreeable smell when dysentery is present, while under normal conditions it is darker in colour, and drier, and is voided at a greater distance from the hive. This spotting of the hives and surroundings usually occurs in spring, when the bees have been prevented from taking a cleansing flight by a long spell of cold weather. When bees winter on thin, watery honey they have to consume greater quantities to produce the required animal heat than when their winter food is of proper density. Bees in a healthy state do not void inside the hive, but when, owing to inclement weather, they are unable to fly, there is, on account of the consumption of a large amount of diluted food, such an accumulation of waste in their bodies that they are forced to discharge it inside the hive, soiling each other and the combs. Before this condition is reached the bees are so surcharged with accumulated waste that they are unable to consume sufficient honey to maintain the animal heat necessary, and many

perish. The cause, as already indicated, is the consumption of watery honey during cold weather. Honey may be too thin for winter food, because it was gathered so late in the season that the bees were not able to evaporate it to its proper density on account of low temperature and humidity of the atmosphere, or it may have absorbed water from the air because it was not sealed and not covered by the cluster of bees.

With the approach of warm weather, colonies suffering from this type of dysentery will recover, provided sufficient bees are left. As a preventive, I would recommend removing all surplus combs and boxes from the hives at the approach of cold weather, and confining the bees to just the number of combs they can cover. If this is done the bees will be prevented from storing outside the cluster honey which they may gather on odd fine days, also the loss by radiation of the heat generated by the bees will be reduced to a minimum, thus economizing in the consumption of stores and avoiding an excessive accumulation of waste matter in the bodies of the bees.

Infectious Dysentery.

This is a disease which has caused enormous losses of bees in Great Britain and Germany. Dr. Zander, of Erlangen, Bavaria, first drew attention to it at a meeting of German bee-keepers held at Weissenfels in August 1909. The disease is a malignant type of dysentery, caused by the invasion of the digestive tract of the bee by an animal parasite of oval shape, which multiplies with great rapidity, and by the destruction of the cell wall of the chyle stomach causes the death of the bee Dr. Zander discovered this organism during 1907 in the intestines of bees suffering from malignant dysentery, and named it *Nosema apis.* This parasite, when in the spore (dormant) stage, is oval in shape, and measures about 1-200 mm. in length by 1-500 mm. in breadth (Figs. 1, 2, 3, 4). Infection is spread by means of the spores voided with the excreta of diseased bees coming into contact with the bees' food or drinking water. The visible symptoms are described by Dr. Zander as follows:—"Sudden mortality of large numbers of bees within or outside the hive. The bees become restless, separate from the cluster, fall off the combs, crawl excitedly out at the entrance, and, unable to fly, collect on blades of grass and other objects, and sooner or later die, the abdomen being more or less inflated."

In May, 1912, the British Board of Agriculture published a report on the bee mortality, known in Great Britain as the Isle of Wight Bee Disease, giving the results of the investigations of Dr. Graham-Smith, H. B. Fantham, Annie Porter, G. W. Bullamore, and Dr. W. Malden In this report the name of *microsporidiosis* is given to the Isle of Wight Disease and *Nosema apis* as its cause. In regard to symptoms, the authors state—Inability of some of the diseased bees to fly, the presence of numerous bees crawling on the ground in front of the hives, and the gradual dwindling of stocks are common, but many other symptoms have been recorded, and no one symptom is characteristic of the disease. The only essential feature is the death of large numbers of bees, and often of the whole stock, especially during wet and cold periods of the year or during the winter months.

The presence of the *Nosema apis* parasite in Australia was first discovered in October, 1909, and made public in the *Journal of Agriculture*, January, 1910. It was then generally assumed that the heavy losses of bees occurring at intervals in certain districts of Victoria and some other States were caused by *Nosema apis.*

Since then the microscopical examination of bees from all over Victoria, the adjoining States, and Tasmania have shown that *Nosema*

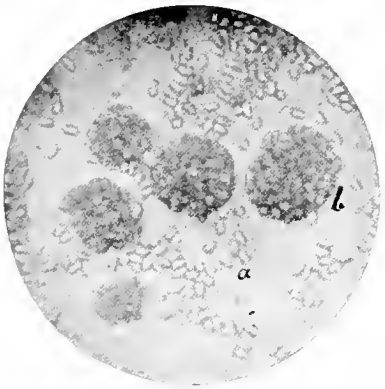


Fig. 1.

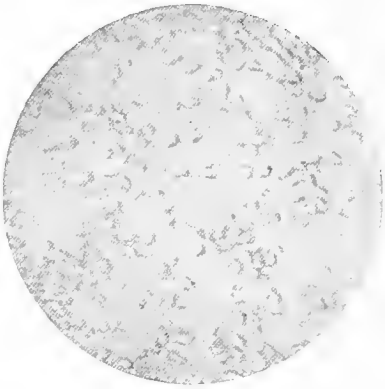


Fig. 2.

Fig. 3.

Fig. 4

[Illustrations reproduced from *Handbuch der Biene*, Vol. II., by Prof. Dr. Enoch Zander:—Figs. 1, 2, Nosema spores, (*a*) single spores, (*b*) intestinal cells filled with spores × 400. Fig. 3, Nosema spores (Australian) (P.), Eucalyptus pollen × 400. Fig. 4, Nosema spores × 1,000.]

apis is present in almost every apiary, and equally numerous in the intestines of bees from localities where no losses have ever occurred Out of 84 lots of 20 bees, each obtained from different apiaries, and examined by Mr. W. Laidlaw, B.Sc., Biologist, Department of Agriculture, only two apiaries were proved free from the parasite in the 20 bees examined. If, therefore, *Nosema apis* is a factor in what is known

as the disappearing trouble, it does not appear to be the only one, since in many localities bees are exceedingly prosperous, notwithstanding the presence of the parasite in their organism.

These micro-organisms were first noticed by Dönhoff and Leuckart in 1857, but regarded as vegetable parasites, *protozoa* being at that time unknown. Bees were then not kept in such large numbers of colonies in one spot, and the frame hive being then not known, new combs had to be built by the bees after every robbing of the hives. With the advent of the frame hive system bees began to be kept in apiaries, numbering hundreds of colonies, the old combs were used for many years, and the swarms hived and placed close to the old hives. Whenever large numbers of animals are kept for any length of time on the same spot diseases break out, unless certain precautions are taken. In the case of bees in a state of nature, their nest is usually some distance from the ground; all refuse and dead bees thrown out, as well as the excreta, fall to the ground out of harm's way. When a swarm issues, it establishes a new home some considerable distance away in clean surroundings, where it builds new combs. In the case of a modern apiary, large numbers of colonies are kept on a comparatively small space; the hives are on the ground, which in time becomes contaminated with exerement, dead bees, and refuse from the hives. The bees are compelled to breed in the same combs year after year. The causation of disease by micro-organisms depends upon the amount of resistance which the invaded host offers and the degree of infection which takes place. A vigorous, well-nourished animal will overcome a degree of infection to which a constitutionally weak one, or an ill-fed one, would succumb. The modern apiarist, by keeping large numbers of colonies on a limited space for years, and using the same brood-combs continuously, has thereby raised the degree of infection to which the bees are subjected, while by breeding his queens for prolificness and colour he has weakened the race and reduced its vigour and resistance to disease.

To counteract these results of the present day system of bee-keeping remedies may be found in the periodical shifting of apiaries on to new ground (the further from the old site, the better), the replacing of the brood-combs with new ones at intervals of a few years, and the restoration of the bees to their original vigour, by breeding all queens from stocks giving the highest yields of honey (an indication of longevity) and not from colonies with an abnormal amount of brood only.

Disappearing Trouble.

Of the cause of the periodical mortality known by the name of Disappearing Trouble or Spring Dwindling nothing definite is as yet known. It appears to be a result of certain climatic conditions in the autumn preceding a winter or early spring honey-flow from certain eucalypts, and is looked upon rather as a condition of the bees than a disease. A characteristic of this trouble is that there are no symptoms. Colonies become gradually, and sometimes rapidly, weaker day by day without more than the normal number of dead bees being visible in or near the hives, while under microscopical examination neither dead nor

live bees from the dwindling colonies differ in any way from bees of normal colonies in districts unaffected. If the dwindling takes place during midwinter the queen and the last hundred or so of bees perish from cold; when it occurs in spring, the bees and queen swarm out and join some other colony when a point of numbers is reached from which the colony could no longer recover. The queens of colonies which dwindled in this way, when introduced to normal colonies in an unaffected locality, do not reproduce dwindling in succeeding seasons, and the combs from which the bees disappeared in no way affected other bees which were put on them.

During the spring of 1909, and again in 1912, heavy losses of bees were experienced in the country near the Grampians, but not in the scrub country on and inside the ranges. In both 1909 and 1912 there was a dearth of pollen in the preceding autumn, followed by a honey-flow from ironbark eucalypts, *E. leucoxylon* and *E. sideroxylon.* The former is known by different names in different localities, such as white ironbark, bluegum, whitegum, and spotted box. The latter is everywhere called red ironbark. Both are winter bloomers, and secrete nectar very freely, but produce no pollen for bees.

It has been suggested that the abnormal activity of the bees during a period when they should be semi-dormant, which is caused by the flowering of ironbarks, causes the premature wearing out of the workers, and there seems to be some force in this contention. The opposition to it is, however, the fact that when the tree variously known as cabbage gum, bastard box, peppermint, &c., flowers during the winter months, bees work freely on it and come through strong. This tree, however, produces pollen freely, and, while but little brood can be reared owing to low temperatures, the nitrogen withdrawn from the body of the bee by the secretion of the enzyme which is necessary for the changing of the nectar into honey, is continuously replaced by the consumption of pollen found on the blossom from which the nectar is gathered, and thus the vigour and vitality of the bee are maintained when gathering from pollen-producing blossoms, but impaired when working on flowers producing nectar only.

Dr. Kramer, a well-known Swiss authority, states that sugar syrup (which contains no nitrogen) fed to bees and extracted contained the same amount of nitrogen as pure honey. The nitrogen was added out of the bee's own organism. "That," Dr. Kramer says, "explains why after being fed sugar, bees are so eager for pollen, also why bees rapidly become enfeebled upon being fed sugar when no pollen or substitute is available" (*Gleanings in Bee-culture,* Dec. 15, 1912, page 817).

As bees do not obtain pollen from ironbark blossoms, a winter flow from that source is the equivalent to heavy sugar feeding with a lack of pollen at the same time, which, as Dr. Kramer further on in the same article says, "so rapidly decimates the colonies."

Pending the collection of further data on this subject, and the discovery of a means of supplying nitrogen artificially, beekeepers in localities liable to this trouble will be well advised to remove their colonies to some other locality during the "off year" preceding the blooming of the ironbark.

XX.—Enemies of the Bee.

The worst enemies to bee-keeping are the three brood diseases of bees comprised under the general term of Foul-brood, and a disease of adult bees called Bee Paralysis. These diseases and their treatment were described in detail in chapter XIX. Other enemies of bees are insects and birds of several species.

Insect Enemies.

Bee Moths.

Bee or Wax Moths are great pests where common or black bees are kept in a careless manner. As a rule, black bees and neglect are found together. There is but little, if any, trouble from Bee Moths in a well kept apiary of Italian bees.

There are two species, the "Larger Bee Moth" (*Galleria mellonella*) and the "Lesser Bee Moth" (*Acchræca grisella*); both species are frequently found in the same apiary; and these pests are present in most parts of the world where bee-keeping is carried on. The larvæ of both moths are great enemies to bees, and may become very destructive. They perforate the comb with burrows, thereby destroying the cells, and often cover it with a network of silken threads. The destruction of the cells and the impediments caused by the silken network partly smother the larvæ, and, as the adult bees are greatly hampered by the threads in feeding them, the larvæ are liable to be starved.

The "Larger Bee Moth," which measures about 1 inch in length, is of a dark brown colour, and the under wings are a light grey on the margin, with a lighter colour towards the centre. When young, the caterpillars are yellowish in colour, and when fully grown are a dull greyish colour.

The "Lesser Bee Moth" is a uniform coloured drab-grey moth, with a yellow head. The larvæ are whitish, with brown heads. They are usually found in Spring, on the floor of hives, amongst the waste wax, which consists chiefly of the caps of the honey cells, emptied by the bees during the Winter. The floor of the hive should, therefore, be scraped clean at the first examination of hives in Spring, and the *débris* removed and burnt. When quilts or mats are used over the frames the larvæ and cocoons of the lesser wax moths are often found between the top bars and the quilt.

In Victoria there are at least four broods in a season; the first, appearing in early Spring from caterpillars that have passed the Winter in a semi-dormant condition, is not so destructive as the others appearing later, because the larvæ, being smaller, eat less than those of the larger sort, and also because they do not spin quite so profusely. Italian or Ligurian bees are not attacked to any extent.

Prevention and Remedies.

A good hive, filled with a strong colony of Italian bees, is the best preventive against these pests. Cleanliness is of the greatest importance, and to obtain this use frame hives. All moths, cocoons, and larvæ should be destroyed when found. All hives should be made of timber

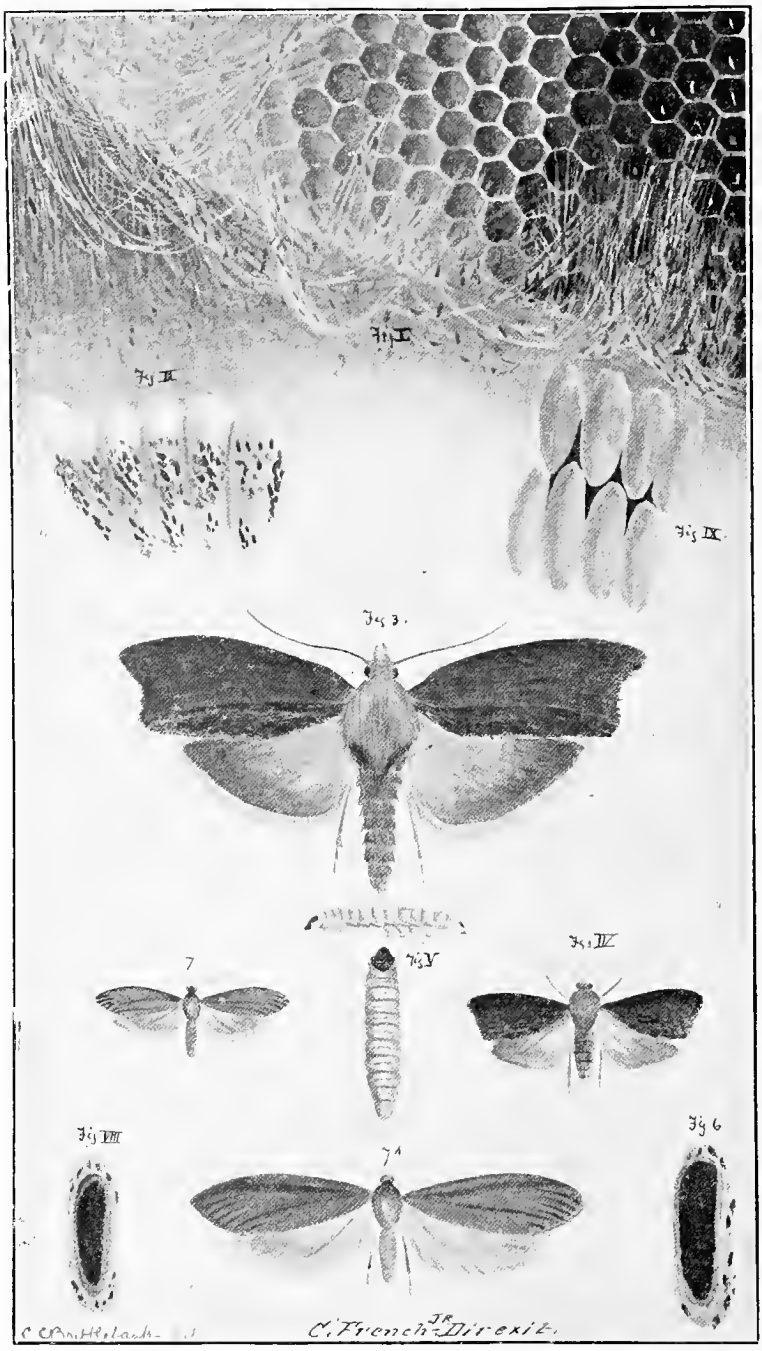


Fig II.
Fig III.
Fig IX.
Fig 3.
Fig V
Fig IV
Fig VIII
Fig 6
C. French Jr. Del. et Lith.

Bee Moths.

sufficiently thick to prevent splitting or warping, and the boxes should fit closely to the bottom board. If the timber is cracked it will enable the moths to enter, and deposit their eggs near the honeycomb.

Empty, or partly filled, combs, removed from the hives at the end of the season, should be at once put beyond the reach of the wax moth. If left standing about, even for a few hours, the odour of the combs attracts the female moths, who deposit their eggs on the combs. The eggs hatch in the following Spring to the surprise of the beekeeper, who carefully secured his combs against moths, and probably only left them about for a little time. The cocoons are attacked by a small species of parasitic wasp which helps to keep them in check.

It is assumed by many beekeepers that wax moths do some good by destroying the combs of bees in trees or neglected hives which had succumbed to foul-brood. Experiments made by Dr. E. F. Phillips, of the United States of America Department of Agriculture, have proved, however, that the spores of foul-brood still remain capable of producing disease after the combs have been totally destroyed by wax moths, and the only point in favour of these moths from the beekeeper's point of view is therefore disproved.

Dragon Flies.

Of other insects which prey upon bees the most formidable is the Dragon Fly. This insect, generally called horse-stinger, is very numerous in some districts. It cruises about over the hives and pounces upon bee after bee, and as it merely draws the juice from the body of the bee and then drops it, a single dragon fly destroys a good many bees during a day. As this insect is very swift and alert, it is difficult to combat. Something like a tennis racket, but covered with a closer mesh, is the most effective weapon to strike them down, and while it would not be

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EXPLANATION OF PLATE.

BEE MOTHS.

"The Larger Bee Moth." (*Galleria mellonella*, Linn.)
"The Lesser Bee Moth." (*Achræca grisella*, Fab.)

Fig. I. Honeycomb showing appearance when attacked. Natural size. From Nature.
Fig. II. Cocoons of *Galleria mellonella*. Natural size. From Nature.
Fig. III. Perfect Insect. Male. Magnified. From Nature.
Fig. IV. Perfect Insect. Female. Natural size. From Nature.
Fig. V. Larvæ of *Galleria mellonella*. Natural size. From Nature.
Fig. VI. Pupa of *Galleria mellonella*. Enlarged. From Nature.
Fig. VII. Perfect Insect of *Achræca grisella*. Natural size. From Nature.
Fig. VII.A. Perfect Insect of *Achræca grisella*. Magnified. From Nature.
Fig. VIII. Pupa of *Galleria mellonella*. Natural size. From Nature.
Fig. IX. Cocoons of *Galleria mellonella*. Natural size. From Nature.

profitable for an adult to engage in the destruction of dragon flies in this manner, boys will readily take to it as a pastime.

Ants.

Ants are often troublesome in an apiary, and while the number of bees actually destroyed by certain species is not very large, they keep the bees in a state of irritation and excitement, resulting in the stinging of persons and animals coming near the hives. There are four out of the many species of ants which annoy bees and their owner more than the rest. These are (1) the Red Ant (Meat Ant), (2) the Sugar Ant, (3) the Black Wood Ant, and (4) the small Black Ant.

Amongst amateur beekeepers and the public generally an idea prevails that to protect bees against ants the hive must be raised on a stand, the legs of which stand in water, or that the hive must by some other means be made inaccessible to ants. When beekeeping is carried on commercially such devices are almost impossible and ineffective. The amount of material and labour required to put even a moderate-sized apiary on ant-proof stands, and the time necessary to keep the devices in working order, would be an altogether too heavy item of expenditure. While this way of protecting hives against ants is, perhaps, the best for one or two hives of bees, it is not only too laborious, but also ineffective in an apiary, for while with constant attention it is possible to keep the ants away from the hive itself, many of the bees returning home heavily laden during a honey-flow alight on the ground near the hive, and there fall victims to ants before they have rested sufficiently to again take wing to reach their home. Where hives are standing directly on the ground, bees alighting on it walk home, which they are quite able to do, although too exhausted to fly. A colony of bees in normal condition, and located in a properly-constructed hive, is quite able to take care of its home, provided any ants' nests in the immediate neighbourhood of the apiary are destroyed.

The Red Ant, which is the most troublesome, is easily traced to its hill, and can quickly be destroyed by means of carbon bisulphide, such as is used for the destruction of rabbits in their burrows. On a cold day, or towards evening, put a tablespoonful of the liquid into each hole and immediately close it up with wet clay. The gas into which the liquid evaporates is heavier than air, and penetrates to the lowest depth of the ants' nest, destroying ants, larvæ, and eggs. Carbon bisulphide is highly inflammable and explosive; great care should, therefore, be exercised in handling it, and no light allowed within a considerable distance of it. Further, to be effective it should not be exploded after it is applied to the ant-hill, as some suppose.

When carbon bisulphide is not available, a temporary expedient may be employed by repeatedly putting ashes on the ant-hill, or covering it up with green bushes; in either case the ants will shift camp, but not infrequently move to a spot nearer to the bees, and destruction is, therefore, the only effective remedy.

Sugar Ants are nocturnal in their habits, and, therefore, often remain unnoticed; they will often establish themselves under hive-stands, and although I have never known them to kill bees, as the Meat or

Red Ants do, yet they annoy bees much after sunset in attempts to enter the hive. Sugar ants may be destroyed with carbon bisulphide as advised above, but if located under a hive the latter should be closed and temporarily removed, but returned to the spot before morning and the bees liberated.

Wood Ants are shiny black ants about ¼ inch in length. They live in holes carried down to a depth of 2 feet occasionally. There is a number of such burrows some distance apart, and sometimes connected with surface tunnels. There are also summer nests made of fibre and pieces of fine grass, and built against the stems of young trees or in stumps and behind the bark of dead trees. This ant is, fortunately, not found in many districts; it is very difficult to deal with, as there are so many small nests not easily found. The distinguishing characteristic of this species is its indifference to cold. It will be found quite active at times when bees are in a semi-dormant state. It is never seen out in sunlight, but keeps in the shade, and does its marauding work mostly at night. Carbon bisulphide applied to the nests whenever found is the only remedy. The small black ant, which sometimes becomes very numerous in apiaries, is distinguished from the former by its more slender build, quicker movements, and much larger colonies. Its objective is honey, as distinguished from the Wood Ant, which preys upon bees.

Of the many ant remedies advertised, some are useless, while others cannot be applied in an apiary, as they would be destructive of bee life.

Spiders.

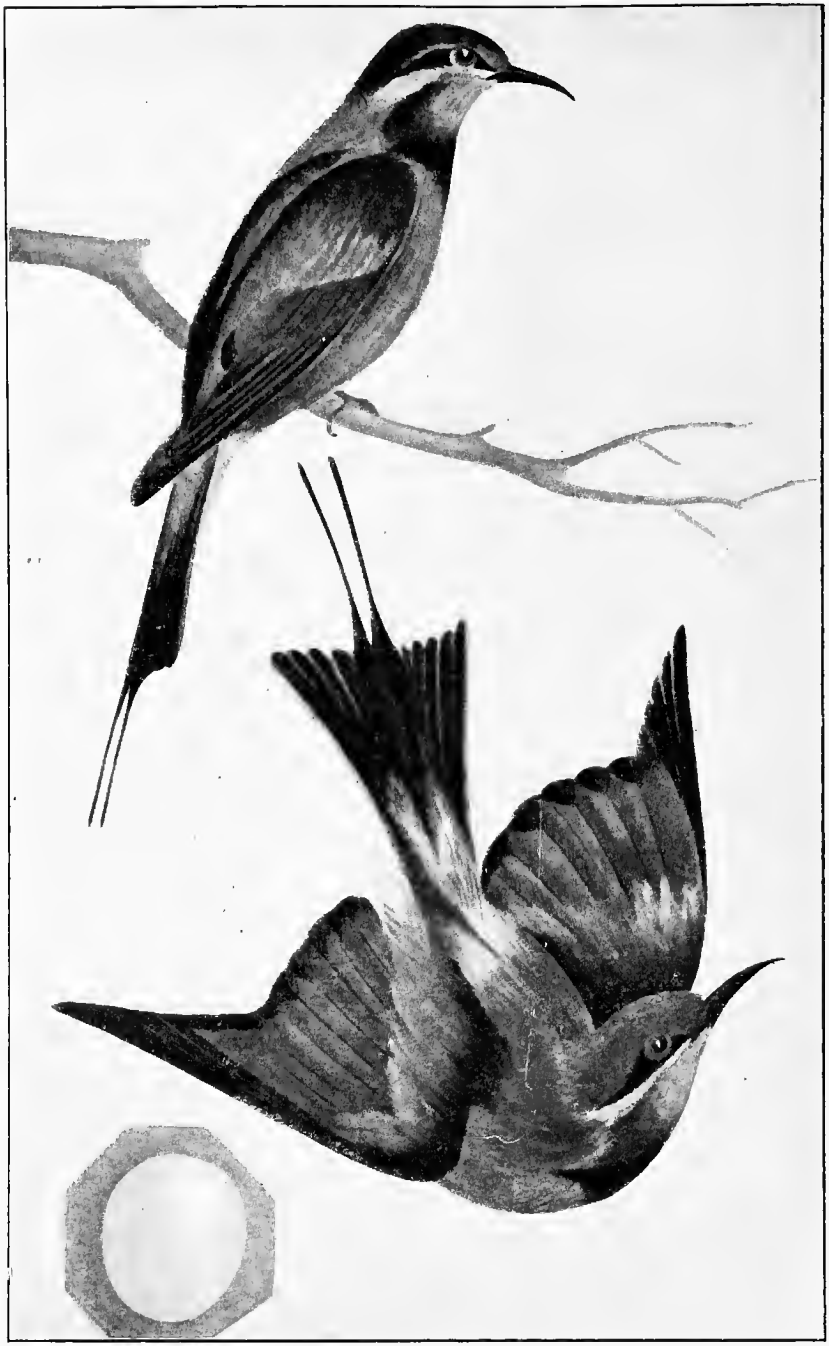
There are several species of spiders which prey on bees. The black spider with a red mark will increase rapidly in an apiary if left undisturbed, and will exact a heavy toll in bees. The lurking places under covers and other shelter spots about hives should be periodically examined, the spiders killed, and the balloon-like cocoons containing their eggs burned.

Birds.

The Australian Bee Eater (Merops ornatus).

As a destroyer of bees this bird holds pride of place. Mr. C. French, in the *Journal of Agriculture* of February, 1902, says: This beautiful bird is unlike any other of our Australian birds, and cannot easily be mistaken. The general plumage of this bird is a beautiful golden green and azure blue, the feathers of the throat being of a rich yellow. Length of bird, according to Mr. Campbell, 10 inches, including tail, 6 inches, and bill 1½ inches, the tail feathers assuming a peculiar shape and colour. The habits of this bird are partially migratory, and the birds are to be found in the northern parts of Victoria. They appear in September, and, according to Mr. Campbell and other ornithologists, leave again in March. The eggs, usually five in number, are deposited in holes made mostly in the sandy banks of rivers.

The bee eater, as its name implies, has a bad reputation as a destroyer of bees, but the strictly insectivorous nature of the bird renders



The Australian Bee Eater (Merops ornatus).

[Illustration from French's *Handbook of the Destructive Insects of Victoria*, Part IV., p 181.]

it, with all its faults, much more valuable than many people think. I have seen the holes in which the young are reared strewed with the remains of beetles, plant bugs, moths, &c., and but very few bees; but these latter the parent birds may dissect before feeding their young. The bee eater is one of the most beautiful of our indigenous birds, and, when on the wing, has somewhat the flight of our well-known and much-esteemed wood swallows or summer birds.

The Wood Swallow (*Artamus personatus*).

Wood swallows, of which there are several species, are much more numerous than bee eaters, and although each wood swallow will, perhaps, eat less bees and more other insects than a bee eater, the aggregate damage done to the beekeeper by wood swallows is much greater than that done by bee eaters. On cool days, when few other insects than bees are about, hundreds of wood swallows will sometimes keep in the vicinity of an apiary for days catching the bees which come out for water, and thus deplete the colonies of adult bees at a time when they can ill be spared. These birds, after catching a bee, alight somewhere and break the bee in two, the abdomen, with the sting, being discarded. On this account a much greater number of bees is required to feed the bird, and the absence of the abdomen of the bee, with its distinguishing coloured rings, in the craw of birds shot and dissected, has led superficial observers to the belief that these birds do not eat bees.

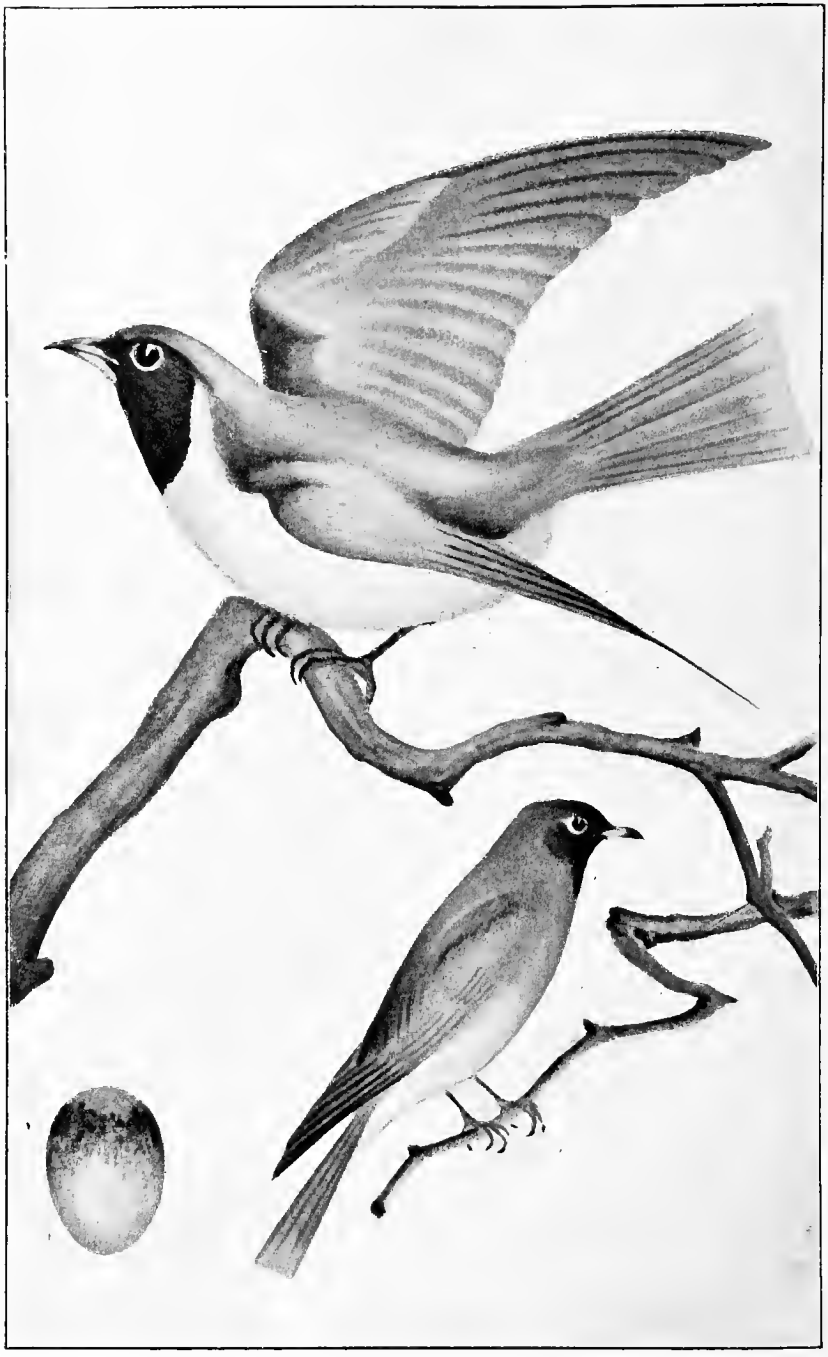
Mr. C. French, in the *Journal of Agriculture* for May, 1902, says of the Masked Wood Swallow, the species illustrated herewith: The male of this species has, according to Gould, the face, ear coverts, and throat jet black, bounded with a narrow line of white, crown of the head sooty black, gradually passing into the deep grey which covers the whole of the upper surface, wings and tail, the latter tipped with white; all the under surface very delicate grey, thighs dark grey; iridis blackish brown; bill bluish at base, becoming black at the tip; legs and feet bluish grey. The female differs principally in having the colouring of the bill and the black mark on the face much paler.

The nests of the wood swallow are frail, and somewhat carelessly built of small twigs and fibre, and in the case of the Masked Wood Swallow half-dried grass is often used as a lining. The nest is built mostly in low trees and bushes, and contains two to three eggs.

There is a number of other birds which eat a few bees occasionally, or take to it as a freak. In the first case the damage done is insignificant, while in the latter the killing of the one or more individual birds will supply the remedy.

Ducks.

Ducks and bees are mutually destructive; that, at least, is the writer's experience. Adult ducks, when once they take to eating bees, cannot be cured of the habit. In the case of young ducklings the evil supplies its own remedy, for, sooner or later, a sting will lodge somewhere in the bird's anatomy, and cause what an uninitiated onlooker would take to be a fatal fit. Adult ducks do not seem to be affected in any way,



The Wood Swallow (Artamus personatus).

[Illustration from French's *Handbook of the Destructive Insects of Victoria*, Part IV., p. 147.]

no matter how many bees they swallow at waterholes where bees come to drink, or which they catch on low flowering plants such as dandelions and clovers. Quite early in his bee-keeping experience the writer was compelled to dispense with ducks, for they would do little else than eat bees from morning to evening. Fowls do not in any way interfere with bees, nor bees with fowls. When insect food is scarce, fowls will eat dead bees, and sometimes drones, but I have never known them to eat live workers.

XXI.—Beeswax.

"Beeswax has its origin in the nectar or honey consumed by bees and transformed by them into fatty matter by a process of digestion and secretion. It is an organic, not a mechanical production, and issues in the form of scales from between the ventral plates of the abdomen of the worker bee." (T. W. Cowan, Wax Craft, page 45.)

The production of wax by the honey bee is in a certain ratio to that of honey; thus, bees in trees or box hives yield, on the average, one pound of wax to twenty pounds of honey. With the introduction of the bar frame hive, and the method of extracting the honey from the combs and returning them to the hive to be refilled with honey by the bees, the ratio of wax to honey has been considerably altered and stands at 1 to 80. In other words, the production of extracted honey for the same weight of wax is four times that of the primitive method of cutting out the combs to obtain the honey. As a result, the price of honey has declined while that of wax has advanced during recent years. The wax is the product of a transformation of the honey or nectar when retained in the body of the bee for a time under certain conditions. Many attempts have been made to turn surplus honey into wax by feeding it back to the bees, but none have proved successful from a commercial point of view. While, therefore, the proportion of wax to honey cannot be profitably increased, so far as its production is concerned, there is room for much improvement in the methods of obtaining the wax from the combs, in the handling, refining and marketing.

Thousands of pounds of beeswax are annually thrown away, or burned with old black brood combs, because the old-fashioned method of boiling the combs in a bag submerged under water fails in obtaining more than a mere fraction of the wax contained in them. New comb consists entirely of wax, and is white or yellow in colour, according to the flora from which the bees obtained the nectar converted into wax. When brood is reared in the cells the comb first becomes brown and, after a time, black, tough, and heavy. Each bee larva, before changing to the chrysalis stage, spins a cocoon, and as generation succeeds generation in the same cells old brood comb contains numbers of these in each cell, one inside the other; but, although the appearance of the comb is entirely changed, the original wax cells are still there. When old brood comb is dissolved by boiling in water each of the cocoons set loose by the melting of the comb becomes coated with liquid wax which clings to the fibrous material of the cocoons, and but little will rise to the surface when boiled in a bag kept under water.

To obtain all the wax, or at least the maximum from old combs, pressure is required—something of the nature of a cheese press. The press shown in the illustration (Fig. 1) is a stout wooden box securely bolted together and lined with tin; inside of this is a slatted grating and bottom, leaving a chamber of 10 x 10 inches (12 inches deep) into which an ordinary sugar bag is inserted. The old comb is dissolved by boiling and poured into the bag, the latter is then folded down, the press block put on, and the screw gradually worked down. Water and wax escape by the outlet into a separating tank which retains the wax, but allows the surplus water to escape.

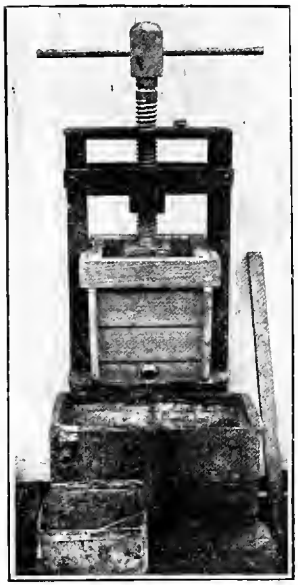


Fig. 1.—Wooden Wax-press.

Fig. 1 shows the press complete, excepting that a board should be fastened across the top of the uprights with a hole to guide the screw, so that it works evenly and steadily. The uprights should either be securely fastened to the floor of a little platform or braced to the wall by stays at the top. The frame consists of two uprights, about two feet eight inches long, made of 6-inch x 2-inch timber, with cross piece of similar dimensions at the top, and a floor piece 12 inches wide near the bottom, the four being mortised and bolted together at the intersections, the screw block being slightly let into the cross piece and bolted. The screw is a 2-inch wooden carpenter's bench screw. The body of the press is made of $\frac{7}{8}$-inch shelving, blocked or dove-tailed together at the corners, and measures $11\frac{3}{8}$ in. x $11\frac{3}{8}$ in. inside by 12 in. deep. The bottom is fitted into the body flat on the underside; the upperside has an incline of 1 inch from the sides to the groove in the centre, which latter inclines towards the outlet in front, as shown in Fig. 2. A frame 3 inches wide runs round the top of the body, bracing it together, and projecting upwards by 1 inch over the top edge of the body, forms a rabbet $\frac{7}{8}$ inch x 1 inch. The whole body is lined with tin inside, the groove terminating in a spout. Figures 3, 4 and 5 show the fittings inside the lining. Fig. 4 is the bottom of the grating, made of pieces of wood $\frac{7}{8}$ inch thick and 1 inch deeper in the centre than at the ends, to correspond to incline of the bottom of the body, on the lining of which they rest. They are $\frac{1}{2}$ inch apart, and slats $\frac{7}{8}$ inch wide by $\frac{5}{8}$ thick, set 3-16th apart, are nailed crossways on to the top of them as shown in Fig. 4.

Fig. 3 shows the four sides of the grating, each of which is unconnected with the others, and consists of slats $\frac{7}{8}$ inch x $\frac{5}{8}$ inch, set 3-16th apart, nailed on to a piece 1 inch x $\frac{7}{8}$ at top, which rests on the rabbet at top of body, when inserted in the latter. A doubled piece of tin in a sawkerf made endways into the slats connects them at the bottom without obstructing the passage of the liquid pressed.

Fig. 5 is the press block, made of a piece of hardwood, with stout iron handle, which is raised and a lever put through when the block is to be lifted. A board ⅞ inch thick and measuring 10 inches x 10 inches (which is the clear measurement inside the grating), fastened to the hardwood block, has slats the same as the sides of the grating.

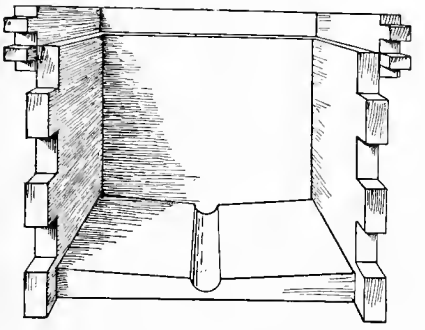


Fig. 2.—Cross Section of Press Box.

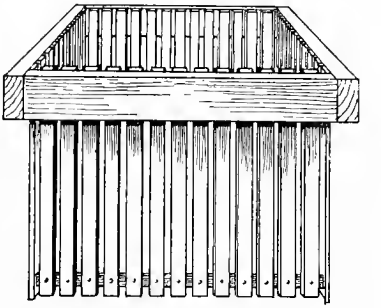


Fig 3.—Inner Slatted Sides of Press Box.

For pressing honey out of cappings or comb, a piece of hessian sufficiently large to lap over double when the press is full, is tucked into the grating. If there is any difficulty in getting the pressed cake out of it it is overcome by drawing out one or two of the sides of the grating.

For pressing wax from combs, press cakes or refuse, it is best to use a bag, just fitting inside the grating. The bag should be of good hessian or similar material, with a square bottom like a woolpack. The wax

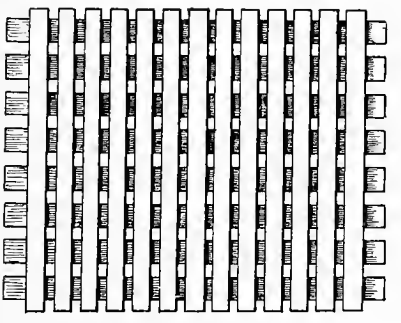


Fig. 4a.—Top view of Bottom of Press Block.

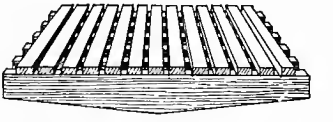


Fig. 4b.—End view of Press Box.

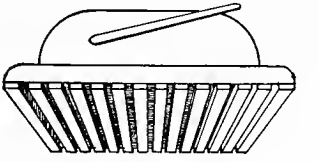


Fig. 5.—Press Block.

should be boiled up with water, and before the first lot is poured into the press, the bag should be inserted and boiling water poured in to prevent the wax adhering to the bag and woodwork when it cools. When fully pressed down unscrew, lift out the press block, shake up and fold the bag afresh, and press again, or pour in more if there is but little

refuse. The liquid wax and water run into a receptacle standing under the spout, and are separated by means of a separating tank described further on.

There are several types of wax presses, and while a wood-slatted one, as the one described, is preferable, its construction requires a certain amount of skill and handiness with tools not possessed by every bee-keeper. A press made almost entirely of metal is obtainable from dealers in bee-keepers' supplies. Fig. 6 is the press ready to set up; also two moulds for wax cakes at the back. In Fig. 7 the different parts are shown.

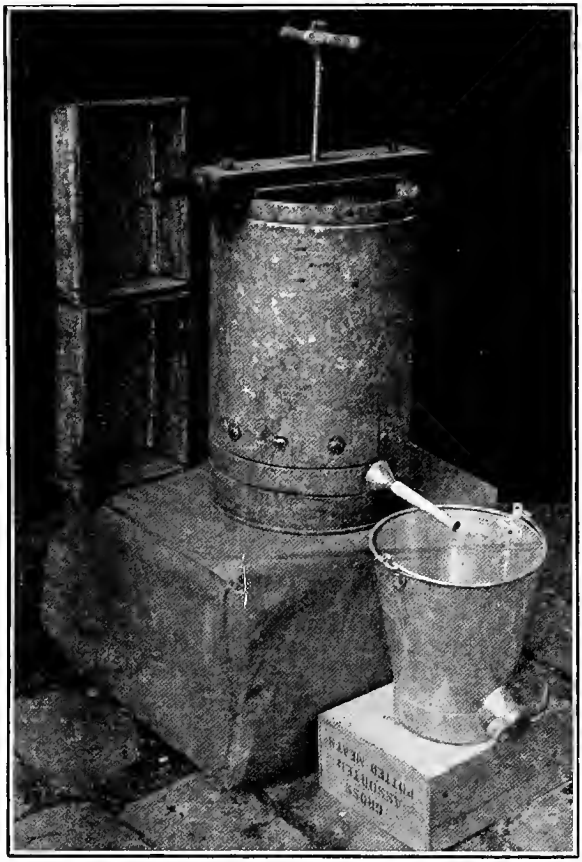


Fig. 6.—Metal Wax Press, set up.

The amount of wax obtained from old black combs by means of a press, as compared with the old method, is as three to one, while the time occupied is but one-tenth, and the wax obtained is ready for market if drawn off into suitable cooling vessels, such as the moulds shown in Fig. 6.

About 75 per cent. of the wax sold by produce salesmen is depreciated in value through having been wrongly treated at the apiary, Wax should never be overheated; it should always be melted or boiled with water. Wax boiled in rusty tins or iron vessels has a dirty brown appearance; contact with galvanized iron or zinc turns it grey, copper green. Bright, new tin or tinned copper vessels are the only ones which do not affect the colour and character of wax. Even the oldest comb will produce wax of a clear yellow or orange colour if properly treated. The size and shape of the blocks of wax seen on the market also leaves much to be desired. The moulds used by many bee-keepers are buckets, old milk-dishes, kerosene tins, wash-tubs, &c., into which the wax has been poured, and left to set quickly in contact with the metal instead

of on hot water. The result is that the dirt, which will pass even through the finest strainer, is diffused all through the lower part of the wax instead of being in a separate layer, which can be scraped off. Quick cooling results in unsightly cracks and clinging to the moulds. Wax is often sent to market in bags, and the fibre and dust adhering to it still further spoil its appearance. Blocks or cakes should not be larger than 20 lbs.; 10 or 12 lbs., however, is the best weight.

Better attention to the saving, proper handling, and marketing of bees-wax would well repay the bee-keeper, and add considerably to the total annual value of production.

When an apiary has been in existence for a number of years it becomes necessary to replace some of the old black brood combs. This should be done every season — whenever an opportunity offers to withdraw them from the brood-chamber. They should then be replaced with new ones.

Fig. 7.—Metal Wax-press showing parts.

A Langstroth comb, if built on a full sheet of foundation, contains about 2 ounces of wax when new, but somewhat more after it has been in use for some years, as the bees add wax after the foundation is first drawn out. When very old combs are boiled down for wax, not more than eight should be put into each tin with three gallons of water, otherwise the mass becomes too stiff and difficult to press clean of wax. Sometimes, hundreds of combs have to be cut out and boiled down and a great number of vessels would be required to hold the water and liquid wax coming from the press until the wax is set, unless it is skimmed off while hot, which is tedious work.

By the use of a separating tank, wax and water can be separated automatically, the wax being retained in the tank while the waste water,

if not too thick and black, can be used for boiling down more combs or else at once disposed of. Waste water from boiling down combs or water containing honey should not be thrown out so that bees have access to it, but should be buried; apart from any risk of spreading disease it may start robbing or stinging.

This separating device (Fig. 8) consists of a plain box lined with tin. One corner of the lining is covered by an L-shaped piece of tin soldered to the side and end, open on top and reaching only to within half an inch of the bottom, with an outlet stud through the end board

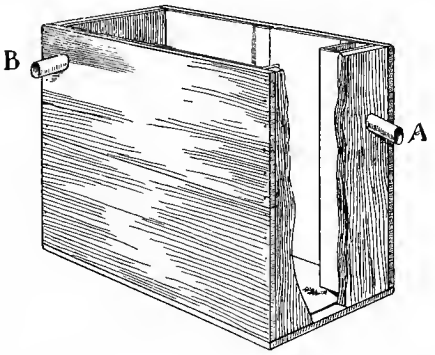


Fig. 8.

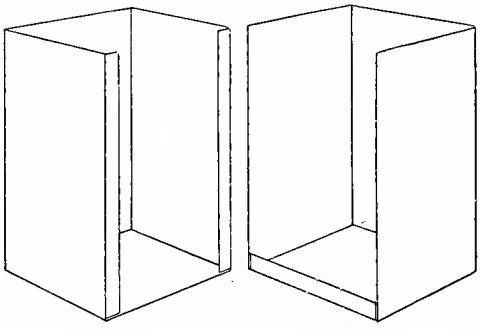


Fig. 9. Fig. 10.

Fig. 8.—Separating Tank. Figs. 9 and 10.—Lining of Tank.

of the case about four inches from the top. At the opposite corner of the case is another outlet stud two inches from the top.

Before allowing the wax to run into the tank from the press, sufficient hot water should be poured in to cover the end of the enclosed corner so as to prevent the wax escaping into it. After several lots of boiled comb have been put through the press, the wax and water will have risen in the tank to the level of the outlet tube A, and from now an amount of water, equal in weight to the water and wax coming from the press, will run over by tube A.

As wax is considerably lighter than water, it does not displace water by its own volume, and therefore rises in the main body of the tank as

it accumulates until it reaches the wax outlet tube B. This is best kept corked till it is desired to draw the wax into moulds or a cooling vessel, when by opening the wax tube B and closing the water outlet A the whole of the accumulated wax flows over when more liquids run into the tank from the press or sufficient hot water is poured into it.

A serviceable tank of this description can be made out of a kerosene case and two tins by any one able to use a soldering iron. Cut the tops out of the kerosene tins, close to the rim, and hammer back the cut edges. Then cut the side out of one tin, as shown in Fig. 9, and the other as in Fig. 10; put the tins into the case, straighten out the pieces left for lapping over in Fig. 9 and the bottom piece in Fig. 10; then solder together. Withdraw the lining from the case, cut the holes for outlets A and B into lining and case, reinsert the lining and solder on the studs (which should be at least one inch in diameter) and the angle piece covering A. The work is then completed.

This receptacle, if emptied and wiped dry after use, will last for many years, as wax has a protecting influence on tin. It will save a great deal of labour by dispensing with skimming and remelting; water will also be economized, an important consideration to bee-keepers who are located in dry districts.

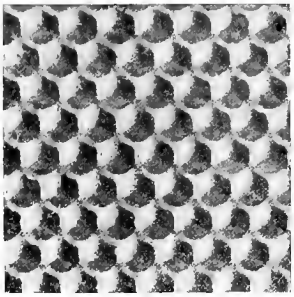
XXII.—Comb Foundation.

Comb-foundation consists of a thin sheet of bees-wax, impressed on both sides with the bases of the smaller or worker cells of honeycomb. It is given to the bees in the modern hive, suspended from the top bars of the frames, kept straight by means of fine wires embedded in the sheets, and is used by the bees as the midrib of, or the foundation upon which they build, the comb.

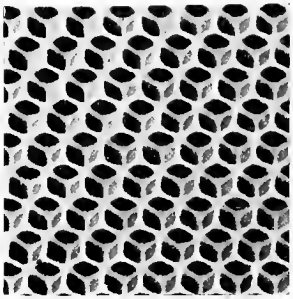
The advantages of using full sheets of foundation in the frames instead of allowing the bees to build comb in their own way are dealt with in another chapter. As comb-foundation is expensive, the very best use should be made of it, and this object is only achieved when the resulting combs are perfectly even and straight in the base, which, in turn, is only possible if the foundation is properly manufactured.

The comb-foundation sold by supply dealers is of the required standard of quality (Fig. 1, E.F.G.H.); but while the price is 2s. 3d. per pound, with 2s. per pound for large quantities, the apiarist only obtains, after allowing for freight and other charges, 1s. to 1s. 3d. per pound for the grade of wax usually made into foundation. In consequence many apiarists have purchased foundation rollers, and make their own foundation. It is, however, questionable, in some instances, at any rate, whether home-made foundation is not as expensive, and less satisfactory as to sagging and buckling, than that purchased from dealers, owing to the extra weight of the sheets and the imperfect embossing.

To turn out sheets, which, without making them too heavy, will be drawn out by the bees into nearly perfect combs, requires some skill, the proper appliances, and a knowledge of the properties of bees-wax under different temperatures during the process of manufacture. Most of the foundation made by beekeepers is either too heavy or imperfectly

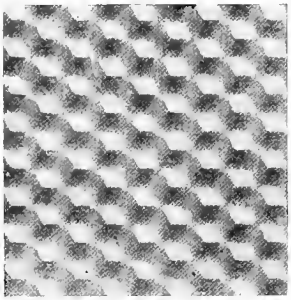


A

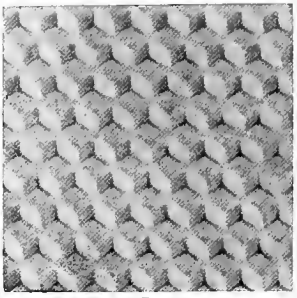


B

A. Surface view
B. Looked through
} Well made round cell foundation.

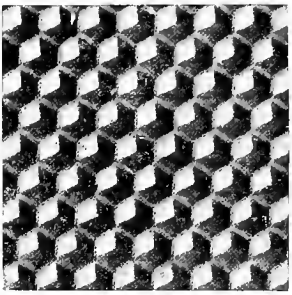


C

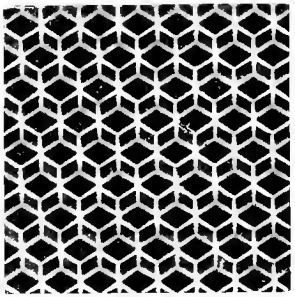


D

C. Surface view
D. Looked through
} Too faintly impressed.

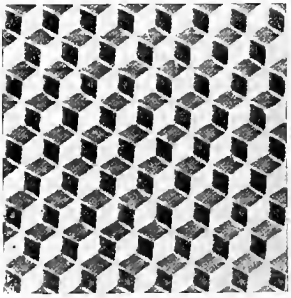


E

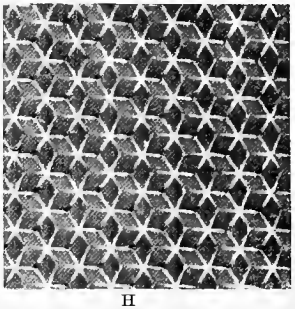


F

E. Surface view
F. Looked through
} Weed process. Brood foundation.



G



H

G. Surface view
H. Looked through
} Weed process. Thin section foundation.

Fig. 1.—Comb Foundation.

impressed, or it may be both. For brood or extracting combs, foundation, eight sheets to a pound, if well made (Fig. 1, A.B.) is quite heavy enough. Many beekeepers, being unable to obtain good combs from medium weight foundation, owing to the sheets being too faintly impressed (Fig. 1, C.D.) make them as heavy as five and a half to six sheets to a pound. This, to some extent, does away with sagging and buckling, but it raises the cost by about 1d. per sheet by unnecessarily using an extra amount of wax. If the rollers of the foundation mill are set close enough to completely fill the interstices between the cell cones of the rollers, while the cell bottoms of the foundation are quite thin and transparent, one pound weight will contain seven and a half to eight sheets Langstroth size. The extra wax in heavier sheets is in the cell bottoms, and adds but little to the freedom from stretching or buckling. To make good foundation, it is necessary to have the proper appliances and to keep the correct temperatures in the process of making the plain sheets as well as in passing them through the rollers.

Texture, Expansion and Contraction of Bees-wax.

If the wax used for foundation is absolutely pure and clean the shade of colour is immaterial if the foundation is intended for brood or extracting combs. For sections, if possible, only the palest white wax should be used. How to obtain bees-wax of the greatest purity and best colour from old combs is described in chapter XXI., page 99. To guard against infection of the colonies wax of unknown origin or from apiaries in which foul-brood exists, particularly when the solar wax extractor was used to obtain it, should always be first boiled with water, allowed to set and the blocks scraped clean before being re-melted for foundation.

To produce the best grade of foundation with a minimum of labour it is necessary to know the properties of wax at different temperatures. Wax is crystalline in texture, and comparatively brittle at ordinary temperatures. When kneaded its structure is altered, and it becomes and remains for a considerable time more or less pliable. Thus a thin sheet of wax, at a temperature of 60 degrees Fahr. is exceedingly brittle, but after being passed through the foundation mill at a temperature of 100 degrees it will be tough and pliable at 60 degrees, more or less, according to the degree of kneading it received from the rollers. The greater the pressure exercised the tougher will be the foundation. In the case of what is known as the weed process of manufacture the wax is subjected to a pressure of several hundred pounds to the square inch, the wax becomes semi-transparent, and the foundation tough, a circumstance which has given rise to the erroneous suspicion that adulterants have been added.

At a temperature from 120 degrees upwards wax becomes friable, and the sheets stretch and tear in handling. At about 150 degrees wax becomes a liquid, and expands more and more as the temperature rises. The greatest expansion of volume takes place between 180 degrees and 212 degrees, which, latter, is the highest temperature wax heated on water can reach. In cooling wax does not contract in the way it expanded, the expansion reached at the high temperatures is retained nearly down to the point of solidifying; thus wax heated to 200 degrees

will contract considerably more on becoming solid than that which never reached more than 170 degrees; hence, wax to be cast in moulds for blocks should be heated to the boiling point of water so that it will easily leave the moulds, while, when intended for foundation, it should not reach more than 175 degrees in the final melting before dipping, otherwise the violent contraction of the sheets when immersing the dipped boards in water will cause cracking and splitting.

Making the Plain Sheets.

The first operation in the manufacture of comb-foundation is the production of the plain sheets of wax. It consists in the dipping of pine boards of given dimensions, and previously soaked in water, into liquid wax, cooling them in tepid water, peeling the sheets off the boards and trimming them ready for the foundation mill. The appliances shown in the illustration and described hereunder, as well as the method advocated, vary to some extent from those generally given in textbooks, but have been found by the writer, after years of experience

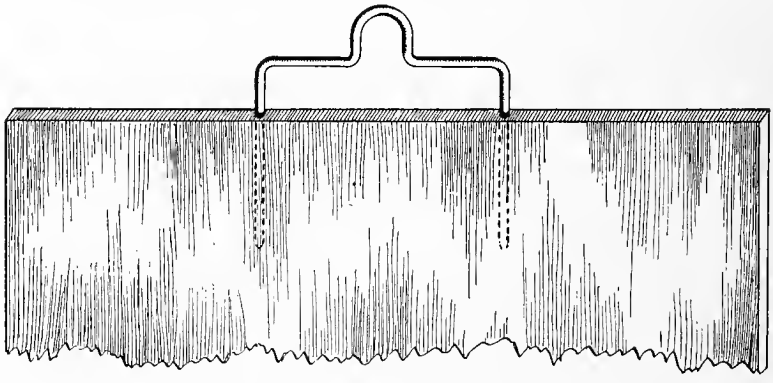


Fig. 2.—Dipping-board (end with wire handle).

and experiments in the manufacture to be the best for the production of first class foundation at a minimum of cost in time and wax. The appliances used may be different in shape, and the working method may be varied to suit the person and the articles available, but the essential features of the appliances and of the method should be retained if perfect workmanship is desired in the finished foundation. The dipping boards should be of the best soft fine-grained pine wood. American shelving, free from knots, will be found the most suitable timber. The boards should be 17 inches long by 9 inches wide and $\frac{3}{8}$-inch to $\frac{1}{2}$-inch thick, planed smooth on both sides. The edges are best left straight and square, as then the sheets are easier to peel off than when the board is tapered or feather-edged. A wire handle (Fig. 2), made of steel wire, such as is found in bicycle tyres, is fastened into the ends of the boards. This will enable the boards to be completely immersed, turned end for end, without getting wax on to the fingers, and hung up on the revolving holder, shown in the centre

of the illustration (Fig. 3), or on a rack of hooks placed in a convenient position.

The boards are first soaked in hot water of a temperature higher than that of the wax to be dipped, otherwise air bubbles, escaping from the boards during immersion in the wax, will blister the sheets. The quickest way of bringing the boards to the proper condition is to stack them with thin strips of wood between and a weight on top to keep them down in water in a tub or a vessel, as shown in the centre of the illustration (Fig. 3). When the water has been brought to the boiling point by means of a stove, the latter is turned down somewhat, and sufficient cold water poured into the vessel to reduce the temperature to 120 degrees, at which it should be kept. To prevent contact with the bottom of the vessel two narrow pieces of wood should be put under the

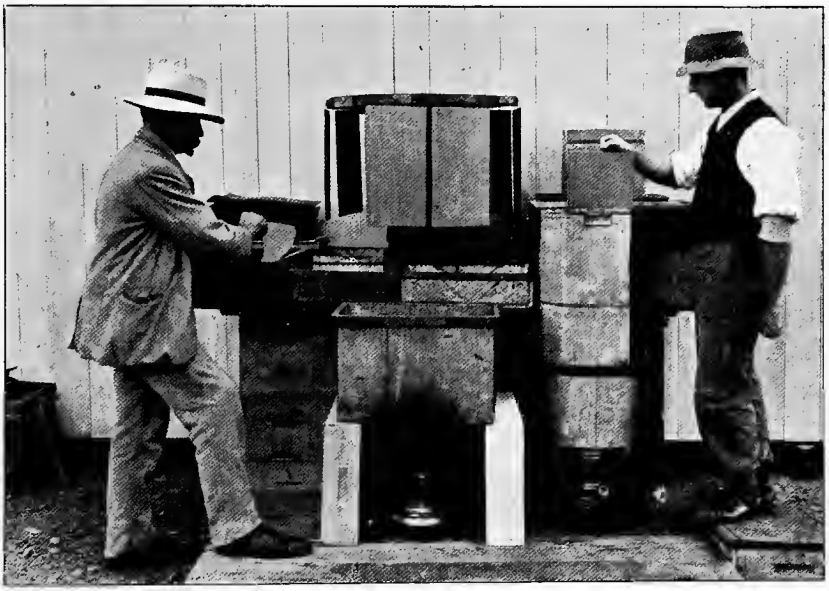


Fig. 3.—Dipping and Peeling off Plain Sheets.

lowest board. These strips and the fine sticks placed between the boards should be soaked in water beforehand, so that no dry spots, to which the wax would adhere, may remain. When the wax is ready in the dipping tank, the boards are taken out of the water one after another as required, and hung up to drain off surplus water so that they are just evenly damp all over. Before plunging it into the hot wax each board is given a shake and turned end for end so that the drier end will enter the wax first. The board is pushed right under, except the top of the handle, quickly withdrawn, held perpendicularly over the dipping tank to drain for a few seconds, then turned end for end again, immersed in the wax, drained, for a moment plunged into water, and then hung up. The next board is then dipped, and so on, the stand being moved round from left to right, one board every time. When the first dipped board comes

round to the operator on the left, the sheets have sufficiently set and contracted to peel off easily. The strips are pulled off the edges and ends, the boards rinsed in the soaking water of 120 degrees and hung up to drain. As each board reaches the operator on the right, it is just of the right temperature and dampness for dipping. The dipped boards are immersed in the dish behind the dipping tank, which is only in part visible in the illustration. The water should be from 90 to 100 degrees; if colder the boards cannot be stripped quickly; if too hot the sheets take too long to set. For two-handed working, as in the illustration, ten boards are required; for single-handed five. In the latter case the boards are all dipped first and then stripped.

The reversing of the boards produces sheets of more uniform thickness than when dipping several times from the same end. Even when reversing one end is smoother and somewhat thinner, and rolling should be from this end. When peeling off, the sheets should be placed on a board, evenly on top of one another with all the thin ends one way. When about thirty sheets have accumulated, and while the sheets are still warm, a straight-edge is put across the pack, and about $\frac{1}{2}$-inch cut off at the thin end with a knife or a disk cutter. This trimming of the ends greatly assists in getting a quick start when rolling.

As already mentioned, the wax should be pure and clean. The most convenient way is to melt it in two vessels, placed inside a larger one containing water. This will greatly reduce the risk of over-heating, and entirely do away with that of boiling over, while insuring a continuous supply. The temperature of the wax should never exceed by much that required for dipping, for reasons previously explained. A special tank, such as the soaking tank shown in the illustration, or a wash tub sufficiently large to hold two 60-lb. honey tins, the top of which have been cut out, may be used. A slow fire or a stove under it will supply the heat.

The dipping tank is a vessel oval in horizontal section, 12 inches wide one way and 3 to 4 inches the other, and about 21 inches in height. It is contained inside a similar tank of somewhat larger dimensions with hot water in the space between. The water is kept at a uniform temperature by means of a blue-flame stove, or other lamp contained in the stand, which supports the double tank, as shown in the illustration (Fig. 3). To obtain sheets of uniform thickness and correct weight, with a smooth surface, free from cracks or blotches, an even temperature of the wax during dipping, and after replenishing the tank is essential. This is accomplished by means of a thermometer, with the bulb in the hot water, and the turning up or down of the flame of the stove. When the dipping tank is first filled with liquid wax from the melting vessels it will take some little time before the temperatures of wax in the inner and water in the outer tank are the same. After that there will be but little fluctuation, unless the wax in the melting vessels from which the dipping tank is replenished is allowed to become too hot. When the supply of wax is exhausted what remains in the dipping tank may be worked out down to a few pounds by adding water of the same temperature as the wax whenever the level of the wax has to be raised to cover the dipping board.

When dipping for foundation seven Langstroth sheets ($16\frac{3}{4}$ inches x 8 inches) to a pound, the temperature indicated by the thermometer should be 155 to 160 degrees, for eight sheets to a pound 165 to 168 degrees, and for section foundation 170 to 174 degrees, and the number of plain sheets in a 5-lb. pack, before trimming, about 28, 33 and 38 respectively.

The foundation mill, as seen in the illustration Fig. 4, consists of two type metal rollers on steel spindles, one above the other, running in bearings set in the cast-iron frame-work. To the projecting axle of the lower roller a crank handle is attached, by means of which, and the cog wheels at each end of the rollers, the latter are revolved. The bearings of the lower roller are fast in the frame, while those of the upper one

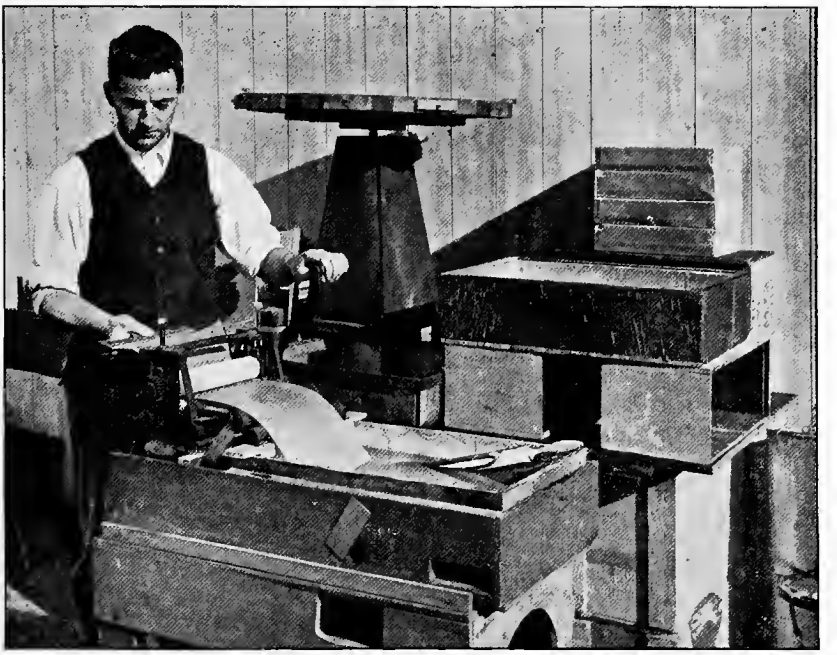


Fig. 4.—Rolling the Sheets.

are capable of being raised or lowered and moved sideways. Rubber cushions, or, in the latest machines, steel springs, between the upper and lower bearings hold the rollers apart, the closer setting being accomplished by means of two vertical set screws, which force down the upper bearings and thus bring the rollers together.

It is absolutely necessary that the rollers should be perfectly parallel, both vertically and horizontally, otherwise good workmanship cannot be expected in the sheets of foundation. The horizontal adjustment is made with the vertical set screws, while the top roller is set true to the lower one, vertically with four lateral set screws at each end. By means of these screws the bearings can be moved slightly sideways. The

machines as received from the manufacturers are correctly set for working, the only adjustment which may be necessary being the raising or lowering of the top roller according to the thickness of the sheets to be rolled and the grade of foundation to be made.

If, however, the rolls by some means should have become untrue in alignment, some exceedingly delicate adjustment of the lateral set screws controlling the upper bearings will be necessary before good work can be done. The rolls, as stated, are of type metal, and are engraved in such a way as to correspond to the cells of worker comb. Each of the multitude of little stamps is hexagon in shape, the top coming to a point formed by three inclined planes. The cog-wheels which connect the rollers are fixed on the spindles in such a way that if the mill is correctly set the point of each cell stamp on one roller falls evenly between the points of three of the cell stamps on the opposite roller; but if the rollers are not set true, holes will be torn in the wax sheet, and the rollers may be damaged, or the three planes which form the cell bottom of the foundation will be uneven in thickness, causing stretching or tearing of the sheet during rolling or sagging after the sheets are fixed in the frames of the hive.

When freeing the interstices of the rolls of particles of wax, or on first loosening the end of the sheet when it comes through the machine, metal prickers or tools of any kind should not be used, as type metal, being soft, is easily scratched. A tooth-pick or a piece of comb may, however, be employed.

The foundation machine should be securely screwed to a table of suitable height, or, better still, to a separate stand, with a flat water tank for warming the wax sheets immediately behind the mill, as seen in the illustration (Fig. 4). The water in which the sheets are warmed before rolling should be 110 deg. Fahr. for ordinary foundation, and 115 deg. to 120 deg. Fahr. for what is known as thin, surplus, or section foundation. The temperature is regulated by means of a stove or lamp under the water tank, and a dairy thermometer in the water. The machine will work best when the rollers are nearly blood warm—that is, when they feel neither warm nor cold to the touch of the hand. If the temperature of the room is less than 75 deg. Fahr., it may be necessary to first warm the rollers by pouring warm water from the tank over them while revolving them, and then allowing them to cool down to the required temperature. After work has been commenced, the continuous passing through of the warm wax sheets will maintain the correct temperature.

To prevent the wax adhering to the type metal a lubricant is necessary; soapy water is generally found to be the best, or an emulsion of starch may be used. This is either kept in a shallow trough, in which the lower roller revolves, or applied to the upper roller with a soft clothes-brush; care should be taken to do so after every sheet. Soap has been objected to as acting on the wax; it does not, however, affect wax in the solid form, and if the trimmings of the rolled sheets are washed in tepid water before being re-melted, the wax will be in no way affected.

To have the sheets of even temperature before they pass through the rollers, and thus secure uniform thickness and embossing, it is best to warm the plain sheets singly instead of putting a whole pack into the

water. Wax being lighter than water, the top of the pack is more or less above the surface of the water, and the sheets do not warm up evenly when in contact with one another. If the stack of plain sheets is kept handy alongside the warm water, no time is lost in warming the sheets singly, for while the warmed sheet is taken out of the water with one hand another sheet is dropped in from the other, so that one sheet is always in the water while another is going through the mill, every sheet being warmed for the same length of time.

If in the dipping of the plain sheets, previously described, the correct temperatures for the different thicknesses are observed, only two dips will be needed for each board instead of three or four, as given in some

Fig. 5.—Trimming Comb Foundation.

of the text-books, and while the reversing of the boards makes a much more even sheet than repeated dipping from one end, it still leaves one end slightly thinner than the other. It is this thinner end which is entered between the rollers; the latter are turned till sufficient of the sheet is through; this is rapidly picked loose with the finger-tips, the loose end caught in a gripper, and a slight strain kept on the sheet with one hand while the handle is turned with the other, when the rolling is done by one operator only. It is important that the right end should go through the machine first, when reversing the boards has been practised in dipping, because the rollers can then be set closer, resulting

in better kneading of the sheets, and, consequently, a better quality of foundation.

The gripper puts an even strain on the sheet in pulling it off the roller. If one has not been supplied with the machine, it can be made by any one. It consists of two pieces of pinewood, 9 inches long, $1\frac{1}{2}$ inches wide, connected at the ends by semi-circular pieces of clock spring, which hold the two pieces of wood apart till closed on the end of the sheet by pressure of the fingers.

The sheets as they come off the rollers are laid evenly end for end on top of one another, the curled end being smoothed down by hand till eight or ten have accumulated, when they are ready for trimming.

Trimming the Foundation.

As the rolled sheets are 9 inches wide and 18 inches to 20 inches long, trimming to the required size ($16\frac{3}{4}$ inches x 8 inches for Longstroth frames) is necessary. This is best done while the sheets are still slightly warm, by placing a board of the proper dimensions on top of the sheets and cutting the edges and ends off close to the board with a suitable knife dipped in soap water or as shown in the illustration (Fig. 5), with a disc cutter warmed over a small lamp. This cutter consists of a circular piece of thin steel sharpened to a fine edge and fastened to an axle 3 inches long revolving in a fork piece fixed in the handle. A dummy cutter of the same size at the opposite end of the spindle insures straight and even cutting, which will be found of great advantage when the foundation is being fastened into the frames.

When quantities of foundation are made something of the nature of a turn-table will be found very useful. This is simply a board fastened to the top of a table or stand by a screw in the centre, round which it revolves. It should be large enough to leave room all round the sheet for the guide wheel of the cutter; and is moved a quarter of a turn after each cut, thus doing away with the necessity of walking round the board to cut the four sides or to shift the pack of sheets.

The trimmed sheets are lifted in a body, and put into packs of not more than 5 lbs., with a straight board between the packs, so that the sheets may set perfectly straight and even.

When comb foundation is kept over through the winter it will sometimes become somewhat brittle, and show a whitish film on the surface. By exposing it for a short period to the rays of the sun, or to mild heat from a stove, this film will disappear, and the sheets become pliable again.

XXIII.—The Use of Comb-foundation.

Comb-foundation is the base or midrib of the combs in the frames of the modern bee-hive. It consists of a thin sheet of beeswax impressed on both sides with the shape of the basis of the cells of honey-comb, and is supplied to the bees with the object of obtaining a larger yield of honey than would be possible were they allowed to build their combs in their own way. The better results obtained by the use of full sheets of comb-founda-

tion, instead of a comb-guide or narrow strip of embossed wax, are due to three factors:—1. A stronger force of worker bees and very few drones. 2. The faster building of the combs for brood and the storage of honey. 3. Stronger and straighter combs.

1. *Stronger Colonies.*

By the use of full sheets of comb-foundation, the number of worker bees is greatly increased, and the number of drones reduced to a minimum, and as the former are producers and the latter consumers only, the profits of bee-keeping depend to a very large extent upon the ratio of worker bees to drones, and this is best regulated by the prevention of the building of drone-comb. The combs built by bees consist of two kinds of cells, one 1-5 inch in diameter, and known as worker cells, the other $\frac{1}{4}$ inch, called drone cells, the former being the cradle of the worker bee, the latter that of the drone.

In a state of nature a large percentage of the comb consists of drone cells, and immense numbers of drones are raised, a provision of nature to insure the fertilization of the queen from one hive by a drone from another

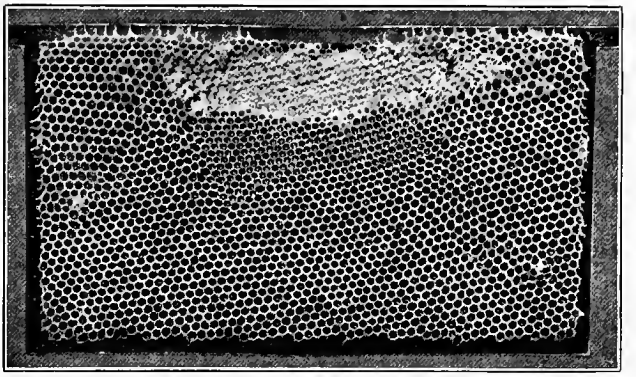


Fig. 1.—Comb Built from Starter, Nearly all Drone Cells.

colony, which, when bees are in their wild state, is often a considerable distance away. In the meeting of the sexes, which always takes place in the air often a considerable distance from the hives, a further safeguard against inbreeding is the aversion of the young queen to drones which come from her own hive, and have the same family odour. When a number of colonies occur close together, as in an apairy, the necessity of large numbers of drones ceases, as a limited number are always raised in each hive. Notwithstanding all efforts to suppress their production, the aggregate number is quite sufficient under the conditions of closer proximity of colonies.

A sheet of foundation is embossed with the pattern of worker comb, 25 cells to the square inch, and as the inside dimensions of a standard frame are 17 inches by 8 inches, there are 3,400 cells on each sire, a total of 6,800. Making a liberal allowance of cells for the storage of honey and pollen around the brood, a comb of all worker cells produces fully 4,500 worker bees (1 lb. live weight) in one generation, while the same comb, but composed of drone cells, would, with the same allowance for

storage cells, produce 2,900 drones. The amount of food and labour necessary for the raising of 4,500 workers is probably the same as for 2,900 drones, but while the workers, from a few days after hatching onwards, engage in productive work, the drones remain consumers to the end.

Further, the presence of large numbers of drones in the hive stimulates the swarming impulse of bees by causing crowding of the brood combs and that condition of the colony which precedes swarming. It will be seen from the above that the use of all worker combs not only increases the amount of surplus honey, but also counteracts in a large measure the swarming propensity of bees. Under certain conditions, which will be dealth with later on, the use of starters instead of full sheets is not only permissible but even advisable.

2. *Faster Comb-building.*

Apart from the advantages of using full sheets of foundation enumerated above, the saving of the time of the bees by the quicker building of the combs and the consequent greater and earlier storing of surplus honey will amply repay the extra cost of foundation. Up to a few years ago

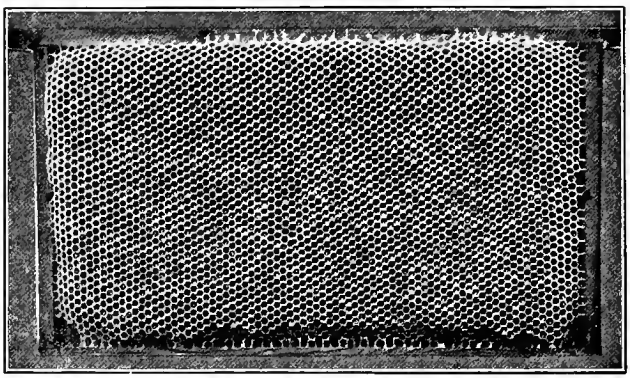


Fig. 2.—Comb from Full Sheet of Foundation, all Worker Cells.

it was assumed that when given full sheets of foundation the bees used no wax of their own secretion and wasted that which they secrete involuntarily when swarming, while quite recently the prevention of the exercise of one of their natural functions, the secretion of wax, has been held responsible for impaired vitality and consequent predisposition to disease. Experiments have shown, however, that no wax is wasted, and wax secretion not interfered with. A sheet of foundation of the grade generally used weighs 2 ozs., while the finished comb built from it weighs $3\frac{1}{2}$ to 4 ozs., showing that an equal or nearly equal quantity of wax of their own secretion was added by the bees. In another experiment, when foundation of a different colour to that of the wax secreted by the bees was used, a cross-section of the resulting comb showed that nearly one-half of the total was newly-secreted wax.

As half the wax composing the combs is given to the bees and the other half secreted by them, it follows that without any interference with their natural functions, double the amount of comb is produced in a given time, thus bringing the colony much sooner into the condition for storing surplus

honey. The speed of comb-building is also accelerated by the larger surface to work upon presented by full sheets as compared to combs from starters.

3. *Stronger and Straighter Combs.*

The importance of good combs for the raising of brood as well as for extracting cannot be overestimated. Even under the most favorable conditions, the combs built from starters are rarely equal to those from full sheets for either purpose. To get the full benefit of the frame-hive system, all combs should be interchangeable without in any way interfering with their utility. This result can only be obtained when the combs are perfectly straight. The correct spacing of the brood combs is $1\frac{3}{8}$ inch from centre to centre; this distance is necessary to allow of all the cells being used for brood, even when the combs are quite straight. When crooked combs are interchanged, the projecting portions prevent that part of the adjoining comb immediately opposite being occupied by brood. This also occurs in combs adjoining drone-brood. To get the maximum number of worker bees reared in the combs of the brood chamber, they should not only be of all worker cells, but also perfectly straight. When the surplus honey is

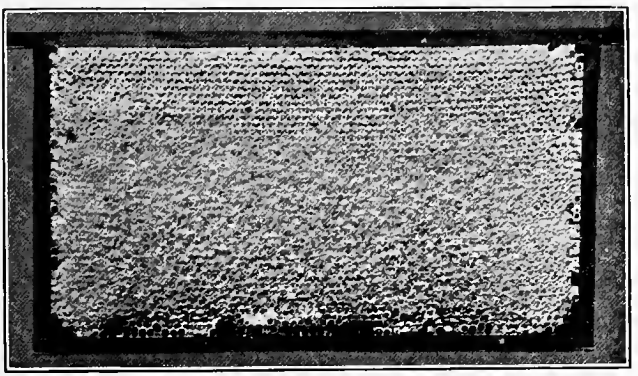


Fig. 3.—Comb Showing Cells Sealed by the Bees.

taken by means of the extractor, and the empty combs returned to the hive to be refilled by the bees over and over again, straight combs are not only much easier to uncap, but suffer less damage in the process than crooked combs, particularly those built from starters, while much time is saved to the operator in uncapping and to the bees in repairing damaged combs. Combs built from full sheets of foundation are also less liable to melt and break down in hot weather, owing to the stronger midrid in the comb and the fastening to the bottom bar of the frame, and no bee-keeper should use starters except under conditions as set forth below.

Worker Comb from Starters.

To get worker comb built from starters, it is necessary to understand the factors governing comb-building. Worker comb is built so long as cells are required by the queen to deposit worker eggs in; under all other conditions more or less drone comb is produced. The production of worker cells, therefore, depends upon the rate of egg-production by the queen and the absence of worker comb already built. The ideal condition is that of

a newly-hived swarm with a prolific queen. If the queen is defective in laying owing to age or lack of vigour, and cannot keep pace with the comb-builders, drone comb will be built. The same result will occur when the bees from the first-laid eggs hatch out before the combs completely fill the frames. As soon as bees hatch out, the queen again deposits eggs in the cells, neglecing the new comb which is in course of construction, and thus causing the building of drone cells. After having hived a swarm on a set of frames with starters, and allowed them to work for four or five days, some of the frames in which little or no work has been done should be removed, and the number thus reduced to what they are likely to fill with comb in the first three weeks after hiving. This rule also applies to colonies which have been shaken down, that is, deprived of their combs, on account of foulbrood. Once bees begin to hatch from the new combs, it is extremely difficult to get further worker combs built from starters, except by removing all the combs but one or two, a procedure better left alone, as it would tend to run the colony down to a very small one. Additional worker combs are best secured by frames with full sheets of foundation given either above or alongside the existing combs.

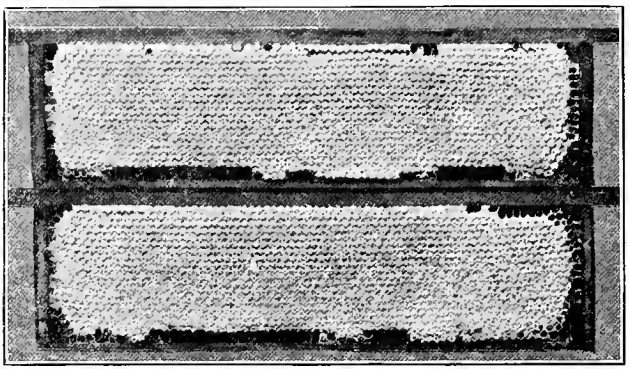


Fig. 4.—Two Shallow Frames of Sealed Comb.

In a good district with a fair honey flow on, large swarms with vigorous queens may fill a section super with honey while building their brood combs from starters, but a queen-excluder should be used between sections and frames. Such favorable conditions do not often obtain, however, and most bee-keepers prefer to hive their swarms on drawn combs of the previous season, and when these combs are occupied, put a set of frames with full sheets on top to get combs for the next season and for extracting purposes. Once two or three sets of combs for each colony are in existence, there is no necessity for further comb-building, as colonies can be kept fully occupied by extracting the combs whenever they are ready for it and returning them to be refilled, while all the wax secreted is required for the capping of the full combs.

It should be understood that the less drone comb there is in a hive, the more likely will drone comb be built when starters are given to an established hive between finished combs. Such a comb is shown in Fig. 1 of the illustrations. Fig. 2 is an unsealed comb built on a full sheet of foundation. Fig. 3 a comb completely sealed over, and Fig. 4 capped combs in half-depth or shallow frames.

XXIV.—Water for Bees.

Few beekeepers are aware what amount of water is required by a colony of bees during the summer months, and how important it is that a permanent supply should be available within a reasonably short distance of an apiary. As a general rule, bees are left to themselves to get their supply of water wherever they can. There is usually a natural water-course, dam, or waterhole somewhere in the neighbourhood, and if permanent and within a few hundred yards of the apiary, such sources answer well enough. When, however, water is not permanently available within a quarter of a mile, it is greatly to the advantage of the apiarist to provide an artificial supply as near the apiary as convenient. I do not think that the time occupied by the bees in carrying water over a longer distance need be seriously considered, but the greater liability of being caught by birds and insects, blown down during strong winds, or caught in rain-squalls during the longer journey is a serious matter. At the margins of dams and water-holes hundreds of bees are often destroyed within a few minutes by cattle or horses stamping them into the mud or swamping them through the plunging of the animals into the water. Where many bees are kept, and the water supply is limited, they become a nuisance to stock, and sometimes a source of ill-feeling between neighbours in consequence. Bees are also very annoying about the apiarist's own home, round water-taps, tanks, and the drinking dishes of poultry, when the weather is hot, and any other supply of water rather far from the apiary. The writer was confronted with all the troubles enumerated when first establishing his apiary in its present location; an automatic artificial supply close to the apiary has overcome these difficulties, and has now been working continuously for fourteen years without a hitch.

The water is obtained from the roof of the honey house and stored in two tanks of 1,000 gallons each. An iron water-pipe, laid underground (18 inches deep) so as to keep it cool in summer, conducts the water to the drinking troughs, which are at a distance of about 100 feet from the building, and the same distance from the nearest hives. This distance is necessary, otherwise the bees, when flying to and from the water, interfere with work in the apiary, and also cause confusion at swarming time. There are two drinking troughs; they are placed on a stand at a height of 3 feet from the ground, in order to prevent poultry going to them, and to keep drifting leaves and other material out as much as possible. Each trough measures 36 inches x 24 inches inside, with a depth of 6 inches, and consists of a frame made of 6 x $\frac{7}{8}$ white Baltic flooring boards, with a bottom of 6 x $\frac{1}{2}$ lining boards. It is lined with plain galvanized iron, No. 26 gauge, neatly fitted inside the wooden casing, to which it is secured at the top with fine tacks. It is better to have two or even three of such troughs instead of a large one of the same surface area as the two or three combined. If only one large trough is used the bees are too much concentrated, and a good deal of fighting and stinging takes place occasionally. It is, therefore, better to have several troughs a little distance apart, and if they are placed on the same level and connected by means of a piece of garden hose attached to a stud at the bottom of each, one stand pipe, with automatic tap, will supply them all. On the top of each trough floats a raft, upon which the bees alight to drink, and it is so constructed that they cannot drown, and even dead bees cannot drop into the water and thus pollute it. The raft

is made of slats of $\frac{1}{2}$-in. lining boards, $35\frac{5}{8}$ inches long, 15-16th inch wide, and $\frac{1}{2}$ inch thick. The edges on the upper side are planed away at an angle of 45 degrees, so that when the slats are placed side by side they form V-shaped gutters, with an opening 1-16th inch wide at the bottom. Twenty-four of these slats are nailed on to three cross-pieces of $\frac{7}{8}$-inch flooring board $23\frac{1}{2}$ inches long and 2 inches wide, in such a way that the thin bottom edges of the slats are 1-15 inch apart. The raft is then fitted into the trough and dressed till a space of not more than $\frac{1}{8}$ inch remains all around between the raft and the lining of the trough. To keep the raft always at the proper level, that is, with the water not higher than about $\frac{1}{8}$ inch between the slats, air-cushions are fastened underneath the raft, one at each end. They are made of light zinc, such as the lining of piano or drapery cases. Fold a piece of this material, cut to the correct dimensions, over a piece of wood 35 inches x 5 inches x 1 inch,

Drinking Troughs for Bees.

solder the joints, and, after withdrawing the board, also the end. It may be tested as to being air-tight by pressing it under water to see whether air-bubbles escape; if so, there is a leak which has to be re-soldered. In soldering zinc, raw spirits of salt, diluted somewhat with water, should be used, not killed spirits (chloride of zinc); this rule also applies to galvanized iron. The solder-iron should be clean, well faced with solder, and only just hot enough to melt the solder, but not the zinc; this is only possible if the solder is of good quality. If the air-cushions raise the raft too high at first the latter should be weighted down to the proper level by means of small stones evenly distributed, and as the wood becomes saturated with water they may be removed as required. The raft of the trough, which is under the stand-pipe, has an upright iron rod pivoted to it in the centre. This rod connects by means of a hinge-joint with a lever fastened to the head of the water tap, which is screwed into

the stand-pipe, so that the cone of the tap is in a horizontal position, and, therefore, lowering the lever will open the tap, and raising close it. No dimensions for rod and lever can be given, as these depend upon the height of the tap above the raft, its distance from the centre of it, and the size and passageway of the tap itself. The measurements and the angle of bend in the tap lever can, however, be easily ascertained. The tap should be completely shut when the raft is within an inch of the top of the trough, but should begin to run as soon as the raft sinks and draws down the lever, when the water level is reduced by the bees drinking.

The accompanying illustration will give a general idea of the arrangement. The troughs shown are of the dimensions stated, and give drinking accommodation for 150 colonies. When the season is very hot and dry, and the colonies strong, a third trough is added by means of a hose connexion, as stated before. The roof of the honey house, with a ground measurement of 21 feet by 18, collects with a rainfall of 20 inches sufficient water for the bees and the ordinary requirement of extracting, &c.

There are many well-timbered areas in Northern Victoria where bee-keeping could be carried on successfully, but which remain vacant owing to the absence of a water supply for the bees. Every beekeeper requires a dwelling and a building for the requirements of his business; if these are constructed in time to get a supply of water for the following season, and if the roof area is sufficient to give the required quantity with the rainfall of the locality selected, there is nothing to prevent some of the waterless, but for beekeeping, otherwise excellent country, being utilized.

XXV.—Bees and the Fertilization of Flowers.

To the apiarist who follows bee-keeping for his living, as well as to the amateur who pursues it as a hobby, the better recognition, in recent years, of the bee as an important factor in fruit-growing and seed raising is very gratifying; because as fruit-growers and gardeners become bee-keepers to the extent necessary to success in their occupations, they acquire a knowledge of the habits of the bee, from personal observations, which will do much to remove the last of an antagonism which at one time was very pronounced.

Without going into the subject of bees and ripe fruit, I wish to state emphatically that bees do not injure sound fruit, but will, under the stress of a dearth of nectar, collect the juices of fruit damaged by rain, birds, and insects other than bees. This fact has been proved by numerous experiments in all countries, and by the experience of fruit-growing bee-keepers, and the opinion still held by a few that bees do attack sound fruit is based on superficial observation, the cracks or fine punctures of the skin of fruit escaping notice.

Relation of the Bee to Pollination of Blossoms.

There can be no doubt that insects play a most important part in the life of plants and flowers. Moths and wasps, bees, and many other insects, all assist in carrying the pollen from flower to flower; but of all insects for this purpose the bee is assuredly the most useful. The first object the bee has in visiting a blossom is to collect either nectar or pollen. The nectar is always lower in the flower than the pistil or

stamens. In passing through the flower the pollen grains attach themselves to the numerous hairs on the body of the bee, and as the insect flies from flower to flower some of the pollen grains are transferred as the bee brushes against the stigma. The same result occurs when the bee is gathering pollen, a substance which is absolutely necessary to the existence of bee life, as not a single young bee can be reared without pollen.

The usefulness and the importance of this work of the bee can hardly be over-estimated, and successful orchard practice will never result until the work of the bee is recognised practically by the establishment or the temporary locating of bee colonies in or near every orchard.

The failure of fruit blossoms to become pollinated occurs chiefly in early spring and during bad weather. To insure as far as possible the pollination of fruit blossoms under these adverse conditions, it is necessary that the hives of bees should be near the flowering trees, that the bees should be of a race or strain which commences brood-rearing early in spring, so that the gathering of pollen for the needs of the brood is carried on even on cloudy and cold days. As black bees are less sensitive to cold and rain, and commence breeding earlier than Italian bees, the first-named and its crosses with the Italian bee will be found more suitable for the fertilization of early blooms.

Condition of Bee Colonies an Important Factor.

The pollen of flowers is used by bees in the preparation of the food of the young bee larvæ, but is not required by adult bees for their own sustenance, which during inactivity consists entirely of honey; further, the time at which brood-rearing commences in spring is, apart from the factor of race, governed by the number of bees a hive contains and the amount of honey present. The stronger a colony is in bees and the richer in stores of honey, the earlier it will start brood-rearing, because considerable numbers clustered together are necessary to produce sufficient animal heat to enable them to rear brood at a time when the temperature is low, and even a large colony will, on the other hand, not start breeding early when short of stored honey. Honey is a good non-conductor of heat, and therefore protects the bees against the influence of the temperature outside the hive, and prevents the loss of animal heat created by the cluster of bees, and absolutely necessary to the rearing of brood. It must also be remembered that the first forage trips of bees early in the season are in search of pollen, not of nectar, and that a colony weak in numbers or short of stores cannot breed early, and does not require pollen. For the purpose of fertilizing early blossoms a strong colony of bees, well supplied with honey of the previous season's gathering, is therefore more effective than a number of weak or half-starved stocks.

Distance of Hives from Trees and Number of Hives Necessary.

The distance to which bees will fly in search of pollen and nectar varies with the season and the weather at time of fruit blossom. On warm sunny days bees will go a mile or more, even in early spring. On cold and cloudy days they do not venture far, and during short snatches of sunshine would probably not visit flowers more than 100 yards distant, if there is no blossom nearer to lead them on.

The bee is guided to the blossom by the sense of smell. When the air current is from the hive to the tree the blossom may not be visited, even though comparatively near, unless the weather is favorable enough for the bee to undertake a circular reconnoitring flight, during which the scent of blossoms is picked up and followed to its source. Whatever may be the guiding sense in the case of other insects, I am convinced that, with the bee, it is that of smell. I have never succeeded in inducing bees to come near artificial flowers which easily deceived the human eye, but can always rely on them finding a drop of honey placed somewhere out of sight.

When bees are kept in or near the orchard the ordinary cleaning flights which bees undertake in spring, whenever atmospheric conditions permit, will bring the blossom within range, but when located half-a-mile away bees cannot be counted on as fertilizers during unfavorable weather.

Fig. 1.—Bees in the Orchard.

As regards location of the hives, I think that they are best placed in a sheltered position where they are shaded in summer, but have the full benefit of the sunshine in winter and spring. This is more easily accomplished by putting them under trees which shed their leaves.

Observations made in the United States in recent years showed that the nearer the bees were to the trees the better was the crop of fruit.

There are as yet no data available as to the number of hives required to fertilize the blossoms of a given number of trees under various weather conditions. Naturally a smaller number is sufficient during fine weather. It is certain that the more bees are kept the better the results. There is, however, a limitation to the number of colonies a fruit-grower can keep permanently in his orchard, as the amount of bee food within the range of the bees' flight during the remainder of the year must be sufficient to maintain them, and to provide winter stores.

The value of bees in the orchard is now so well recognised in the United States that in many instances where fruit-growers have none or not sufficient bees of their own they practically hire bees from bee-keepers for the fruit bloom, providing standing room for the hives in the orchard, and doing the carting of the bees to and from the orchard.

It is, however, not in the orchard alone that bees are of the greatest importance to agriculture, but also in the production of small fruits and farm crops. Dr. Phillips, of the United States Department of Agriculture, estimates the annual value of bees for the fertilization of flowers in the United States at many million dollars, apart from the production of honey and beeswax.

Where cucumbers, melons, and similar plants are cultivated on a large scale, it has been found necessary to establish apiaries, as the number of bees and other insects present was insufficient to effect the pollination of the blossoms. Where early cucumbers are raised under glass, hives of bees are located in the green-houses, and the labour of transferring the pollen from the male to the female blossoms is thus saved. At Cape Cod, in Massachusetts, hundreds of acres of cranberries are grown. It was discovered, according to Mr. E. R. Root, who paid a visit to the locality (Gleanings in Bee Culture, 15th July, 1913) that the yield per acre could be enormously increased by having bees within convenient access. Formerly wild bees in the locality had been sufficient to do the work of pollination for the cranberries. The United Cape Cod Cranberry Company has something like 700 acres of cranberries, which it is proposed to increase to 2,000. On one side of one lot of 126 acres there were three or four colonies of bees. It was evident that this number was inadequate to cover the whole field. It was very significant that the yield per acre of berries was in direct proportion to the proximity of such acreage to the bees. The yield was heaviest close to the hives, and was thinner and thinner as the distance from the hives increased. The showing was so remarkable that the company proposes to increase materially their investment in bees. What the company wants is cranberries, honey being only a secondary consideration.

Bees and the Spraying of Fruit Trees.

It is an accepted fact that the bee is the most useful of all insects in conveying pollen from flower to flower for fertilization purposes. It is also known that to exclude bees and other insects from the blossoms is sure to result in a considerably reduced crop of fruit. It has been frequently stated, especially in publications dealing exclusively with the honey bee, that spraying fruit trees while in bloom will cause great mortality amongst the bees. As the spraying of fruit trees is compulsory, it would appear to be a great anomaly that orchardists should destroy the bee, their best friend, by spraying the trees when in full blossom, when spraying before the blossoms are open or after the petals have dropped is said to be more effective and then harmless to bees. In the United States much damage appears to be done to bees by spraying while the trees are in bloom, and legislation is proposed to put a stop to the practice. The reports as to the destruction of bees seem to be well vouched for. Professor H. A. Surface, in reply to the question, "What kind of spray is best to use when peach trees are in bloom?" gives an emphatic answer as follows:—"I note with interest

that you make inquiry concerning the kind of spray to use while the trees are in bloom. Again I hasten to say that you are decidedly wrong. Please get it out of your head now and for ever, for your own sake and that of your crop as well as for the bees, that no trees, shrubs, bushes, or vines of any kind should ever be sprayed while in bloom."

With the object of arriving at some definite conclusions as to in how far American experience applied to Victoria, observations were made in the orchard of the Horticultural School at Burnley by Mr. E. E. Pescott, the principal, in conjunction with the writer. The results of the first season's observations were recorded in an article, "Bees and Spraying," published in the *Journal of Agriculture* for January, 1912, from which I extract the following:—

It is often considered that bees are able to collect a good store of honey from fruit tree blossom, and that the yield of fruit tree honey

A portion of the Burnley Apiary, showing hives under fruit trees.

comes at a time when the bees urgently need it for brood-rearing. That may be so in other countries, but it does not appear to be so in Australia. Here, the nectar flow seems to be somewhat weak, and insufficient in quantity for the necessities of the bees. A Victorian apiarist during the past season removed his bee colonies from his home to a district where the bees had an available range over 15,000 fruit trees. He ultimately found that the bees were starving, and he had to remove them to a more suitable locality. It may thus be found that the chief use of bees in the orchard will be for cross-fertilization purposes.

Whenever losses of bees occur in apiaries located in or near orchards in which spraying is practised, the owners assume that the mortality is due to the poisons used in the spraying mixtures. So far, there appears to be no proof that bees gather poison along with nectar and

pollen, nor is there any instance on record of the poisons having been proved, by analysis, to be present in dead bees, bee larvæ, pollen, or honey.

Dead bees may often be found not only on the blossoms of fruit trees which were not sprayed, but also on acacia and other flowers blossoming at the same time. Heavy losses of bees from unknown causes occasionally occur at the time of fruit bloom in localities where there are no fruit trees at all; while, on the other hand, apiaries located close to orchards in which the trees were sprayed repeatedly, suffered no perceptible loss and were in a thriving condition. Again, bees might not be affected by the amount of poison gathered with the nectar, but it might be sufficient to kill the brood. In an independent experiment made last season, iron sulphate, 1 part in 400 of sugar syrup, was quite harmless to bees, but killed all the brood.

At the Burnley orchards, there are altogether over 1,800 varieties of fruit trees, which bloom at various times—from the end of August to the beginning of November. Hence, the trees, particularly the apple and pear trees, must be sprayed at a time when some of them are in bloom, with both Bordeaux mixture and arsenate of lead. And this occurs every season.

During last year, the pear trees were sprayed with Bordeaux mixture when some were in blossom; while, later on, a number of apple trees were sprayed with lead arsenate when in bloom. Under these circumstances it was decided to make observations in order to establish reliable data on this question.

At the Burnley apiary, the bee hives are right under the fruit trees, and at the time of spraying with Bordeaux mixture the ground had not yet been ploughed, so that the spray fell not only on any fruit blossoms which were open, but also on the Cape weed then abundantly in bloom.

Neither the spraying with Bordeaux mixture nor the subsequent one with arsenate of lead had any effect whatever upon the bees, the colonies developing normally and without any check; there was not at any time dead brood in the hives. There is no doubt that under the atmospheric conditions prevailing at the time the spraying of the trees proved quite harmless to bees.

The apiary at the Burnley Horticultural Gardens was established before the 1911 fruit bloom to which the report quoted refers. Since then observations have been continued extending over two additional seasons, and although atmospheric conditions were somewhat different the results are identically the same. There were no dead bees and no dead brood with the single exception of a few dead larvæ in one hive into which, owing to its backward tilt, a quantity of the arsenate of lead mixture (about a fluid ounce) had entered; the spraying being exceptionally heavy and the floor of the hive projecting several inches beyond the hive body. The liquid had, perhaps to a slight extent, been used instead of water. Diligent search failed to find more than five or six dead larvæ.

Requests made during two season's lectures on bee-keeping for authentic information as to the poisoning of bees by spraying and for bees which died of the poison have elicited no response, and so far as this State is concerned not a single case of poisoning by spraying has been proved up to the present.

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